



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
09.07.2008 Bulletin 2008/28

(51) Int Cl.:
E04B 1/18 (2006.01) E04B 1/34 (2006.01)

(21) Application number: **06729919.8**

(86) International application number:
PCT/JP2006/305971

(22) Date of filing: **24.03.2006**

(87) International publication number:
WO 2007/049369 (03.05.2007 Gazette 2007/18)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(72) Inventors:
• **TAKESHIMA, Ichiro**
Minato-ku, Tokyo 1058450 (JP)
• **KAMOSHITA, Tsutomu**
Shibuya-ku, Tokyo 1500031 (JP)

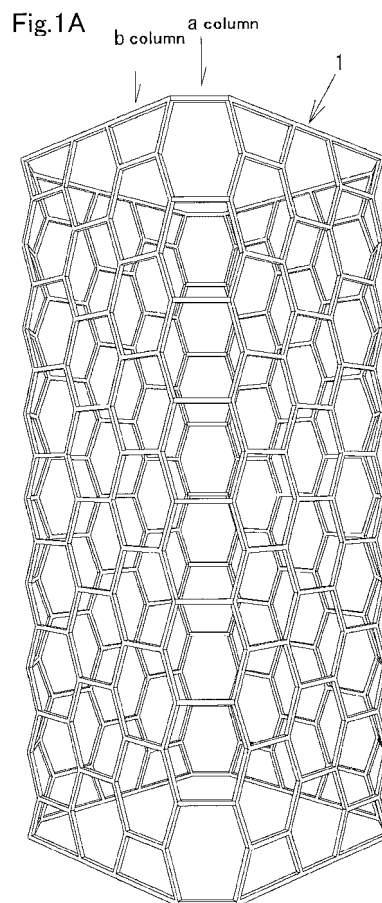
(30) Priority: **25.10.2005 JP 2005310359**

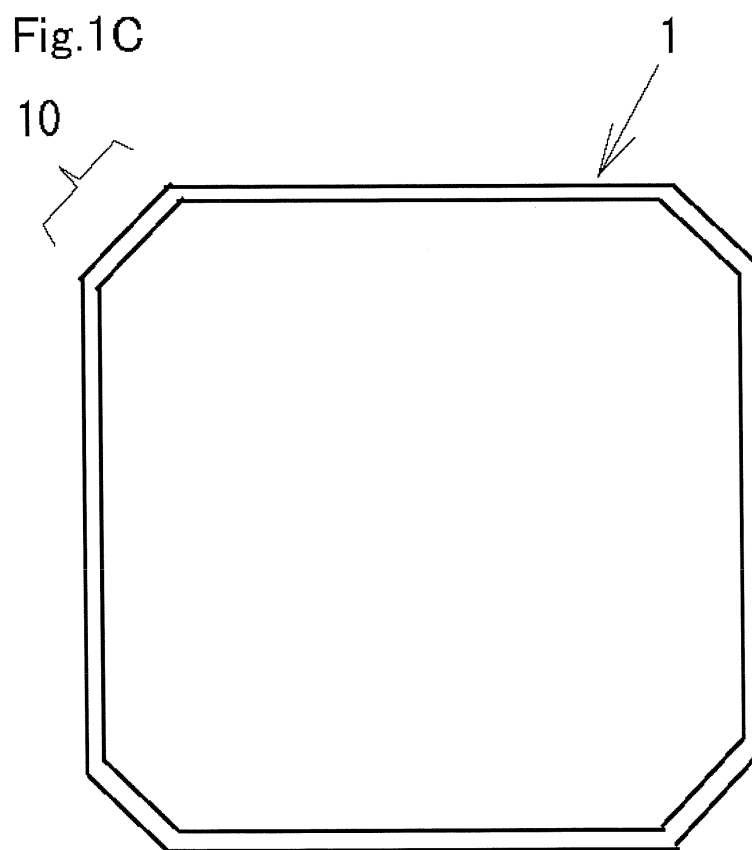
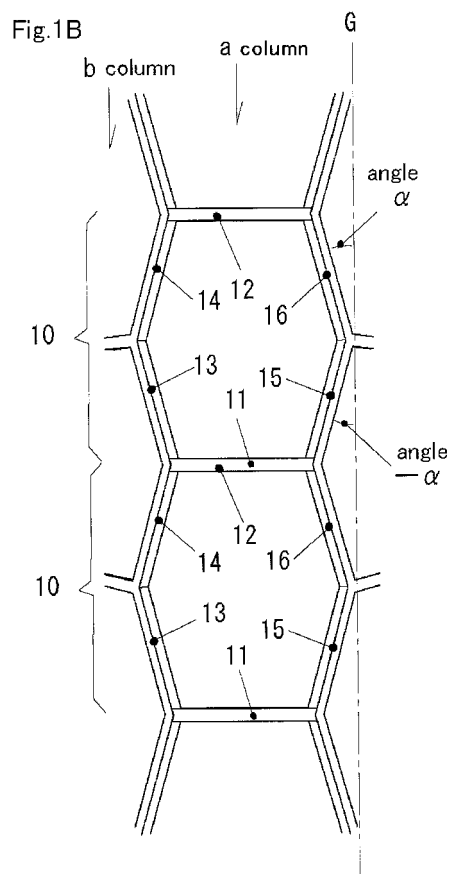
(74) Representative: **Rieder, Hans-Joachim et al**
Rieder & Partner,
Corneliusstrasse 45
42329 Wuppertal (DE)

(71) Applicant: **SEKISUI CHEMICAL CO., LTD.**
Osaka-shi,
Osaka 530-8565 (JP)

(54) **BUILDING STRUCTURE**

(57) An architectural structure comprises an outer peripheral tube frame as a main frame in which a hexagon structural unit is rigidly connected in a honeycomb-shape. The hexagon structural unit includes a pillar and a beam or one part of a slab. Concretely, the hexagon structural unit provides with two edges such that the right side and the left side are symmetric. Two edges are edges of two inclined pillars are connected. Two inclined pillars are inclined in an opposite direction, along a perpendicular direction. The beam or one of the slabs is respectively placed at an upper edge and a lower edge along a horizontal direction. Thus, an architectural structure comprises a tube frame having a novel basic structure. Thereby, stability and earthquake-resistance of a structure can be obtained in an architecture building, specially, a high-rise and a super high-rise buildings. Stability and earthquake-resistance of the structure are superior to a conventional structure. Further, a design can be more free than that of the architectural structure of a conventional tube frame.





Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an architectural structure more particularly, the present invention relates to a structure having a tube structure or the structure of a skeleton.

2. Description of the Related Art

[0002] Conventionally, a rahmen frame (rigid frame) is well known as the architectural structure of a high-rise or a super high-rise architectural structure. The rahmen frame is comprised of a pillar and a beam combined in a three dimensional lattice-shape. However, there was a disadvantage that an inner design is greatly limited because beams are arranged among all pillars. In contrast, a tube frame is comprised of pillars which are continuously arranged on the outer periphery of a building and beams connecting pillars. The tube frame can obtain a space without the pillar or the beam in the inside. Thereby, there is an advantage that a design is highly free. In addition, the overall building is deformed in a tube-shape, thereby, earthquake-resistance and wind pressure-resistance are superior.

[0003] In a patent reference 1, a common use zone is formed at the center thereof and a dwelling zone is formed on an outer periphery. An outer peripheral tube frame is formed. The structure of the outer peripheral tube frame is that of the general rahmen frame of a quadrilateral lattice-shape having an outer peripheral pillar on the outer periphery of the dwelling zone and an outer peripheral beam between pillars. An inner peripheral tube frame is formed. The structure of the inner peripheral tube frame is the general rahmen frame comprised of an inner peripheral pillar and an inner beam between inner peripheral pillars, in the common use zone. This publication discloses a double tube structure having the outer peripheral tube frame and an inner peripheral tube frame.

[0004] A patent reference 2 also discloses a double tube structure having an outer peripheral frame and an inner peripheral frame. The outer peripheral frame and the inner peripheral frame are the general rahmen frames.

[0005] A patent reference 3 discloses a building having an outer peripheral tube frame which places braces intersecting within lattices of a general rahmen frame comprised of a vertical pillar and a horizontal beam. In the inside, this outer peripheral tube frame has a diaphragm in a slab-shape to obtain resistance and solidity, like a conventional rahmen frame.

[0006] Conventionally, a honeycomb structure, in which hexagon lattices are continuously connected, is known as a strong structure. The honeycomb structure is used at various points of a building and the member

of the building (disclosed in a patent reference 4 and a patent reference 5 etc.). In a structure applied to a tube frame, the honeycomb structure is formed by continuously connecting hexagon units in a horizontal plane, e.g., as disclosed in a patent reference 6. It is known that the honeycomb structure as mentioned above is stacked via a stud. The honeycomb structure is stacked in a perpendicular direction.

[0007] A reference 1 discloses a building in which a steel member in a honeycomb-shape is provided on a curved surface course, and a pillar bears inside of the building. In the steel member in the honeycomb-shape on the surface course of this building, the hexagon lattices having the same shape are not equally connected in balance. Each edge of a lattice is not a general linear member (pillar or beam etc.).

Patent reference 1: Unexamined Japanese Patent Application No.2002-317565

Patent reference 2: Unexamined Japanese Patent Application No.2004-251056

Patent reference 3: Unexamined Japanese Patent Application No. H 07-197535

Patent reference 4: Unexamined Japanese Patent Application No.H09-4130

Patent reference 5: Unexamined Japanese Patent Application No. H 10-18431

Patent reference 6: Unexamined Japanese Patent Application No. H 09-60301

The reference 1: "Imagining Ground Zero"(P.137) written by Suzanne Stephens, translated by Hiroko Shimoyama, published on December 1, 2004 and published by EKnowledge.

[0008] The basic structure of a conventional tube frame is a general rahmen frame in which quadrilateral lattices are connected. Quadrilateral lattices comprise a vertical pillar (stud) and a horizontal beam. In order to obtain some structural stability and some earthquake-resistance in a high-rise building or a super high-rise building, the only outer peripheral tube frame is not enough. Pillars of the outer peripheral tube frame and/or inner tube frame are arranged in more than some densities. The inner tube frame is provided. The outer peripheral tube frame and the inner tube frame are connected by a flat slab or a specific beam. Further, a sub frame is incorporated into the outer peripheral tube frame. A plurality of outer peripheral tube frames are continuously connected each other. In most of cases, aforementioned various limitations of a structure are essential. For example, it is essential that a frame is at least a double tube frame in the patent references 1 and 2. It is essential that a diaphragm in a horizontal slab-shape is provided in the inside, in the patent reference 3.

[0009] When the general rahmen frame comprised of the stud and the horizontal beam as the basic structure of the tube frame is applied as a structural unit, various limitations are necessary on the high-rise building, spe-

cially the super high-rise building, in order to obtain strength on the structure. As a result, freedom on a design is reduced. Freedom is the advantage of the tube frame.

[0010] In the honeycomb structure applied to the tube frame, the honeycomb structure is provided in a horizontal plane and stacked via the stud in the perpendicular direction, as disclosed in the patent reference 6. The stud like the general rahmen frame bears a perpendicular load. In the reference 1, the steel member in the honeycomb-shape is provided on the surface course. However, a bearing pillar is necessary in the inside and the only surface course does not bear the overall.

SUMMARY OF THE INVENTION

[0011] Therefore, it is object of the present invention to provide an architectural structure comprising a tube frame having a novel basic structure, which is different from the basic structure of a conventional tube frame. In the present invention, it is object to obtain stability and earthquake-resistance of a structure by the only outer peripheral tube frame in the architectural structure applied to a high-rise and a super high-rise building. Stability and earthquake-resistance of the structure in the present invention are superior to those of a conventional structure. In addition, it is object to obtain, on a design, freedom higher than that of the structure of a conventional tube rahmen frame.

[0012] According to an aspect of the present invention, an architectural structure comprises an outer peripheral tube frame as a main frame where each edge of a hexagon structural unit having six edges is shared with an adjacent unit and each edge is rigidly connected to the adjacent unit in a honeycomb-shape; in which the hexagon structural unit arranges two edges such that right and left are symmetric, two edges where two inclined pillars inclined in an opposite direction are connected, and any of a beam or one part of a slab is respectively provided at an upper side and a lower side along a horizontal direction.

[0013] According to an aspect of the present invention, an architectural structure comprises a plurality of slabs as a main frame at the same interval as height of the hexagon structural unit.

[0014] According to an aspect of the present invention, an architectural structure comprises a sub frame, in which a space between slabs is partitioned into four layers.

[0015] According to an aspect of the present invention, an architectural structure comprises a plurality of slabs as the main frame at the same interval as one-second height of the hexagon structural unit.

[0016] According to an aspect of the present invention, an architectural structure comprises a sub frame, in which a space between slabs is partitioned into two layers.

According to an aspect of the present invention, an ar-

chitectural structure comprises

a portion for having a plurality of slabs as the main frame at the same interval as height of the hexagon structural unit and

5 a portion for having a plurality of slabs as the plurality of main frames at the same interval as one-second height of the hexagon structural unit.

[0017] According to an aspect of the present invention, an architectural structure comprises one or a plurality of pillars placed in the inside, as the main frame, extending in a perpendicular direction in the inside of the outer peripheral tube frame.

[0018] According to an aspect of the present invention, an architectural structure comprises one or a plurality of inner tube frames as a main frame where
10 a second hexagon structural unit is rigidly connected in a honeycomb-shape in the inside of the outer peripheral tube frame.

[0019] According to an aspect of the present invention, an architectural structure in which height of the second hexagon structural unit is one-second of that of the second hexagon structural unit.

[0020] According to an aspect of the present invention, an architectural structure in which the outer peripheral tube frame and the inner tube frame are connected via
25 the slab or the beam as the main frame.

[0021] According to an aspect of the present invention, an architectural structure comprises the slab as the main frame in the inside of the inner tube frame.

[0022] According to an aspect of the present invention, an architectural structure in which inside of the inner tube frame is void.

[0023] According to an aspect of the present invention, an architectural structure in which the slab is a flat slab or a slab with a beam when the slab as the main frame is provided.
35

[0024] According to an aspect of the present invention, an architectural structure comprises a part in a dome-shape in which a plurality of pentagon structural units are inserted at the top of the outer peripheral tube frame.
40

[0025] According to an aspect of the present invention, an architectural structure, comprising a tube width shift part that a plurality of pentagon structural units are inserted at one part of the axis direction of the outer peripheral tube frame; in which
45

width of the outer peripheral tube frame at the upper part of the tube width shift part is narrower than that of the outer peripheral tube frame at a lower part.

[0026] According to an aspect of the present invention, an extension architectural structure comprises a plurality of the architectural structures where two adjacent architectural structures share with the hexagon structural unit of one part of each outer peripheral tube frame and two adjacent architectural structures are connected each other.
55

[0027] According to an aspect of the present invention, the extension architectural structure comprises a plurality of architectural structures where each of the plurality of

architectural structures is spaced each other and is connected by a beam or the slab as the main frame.

[0028] According to an aspect of the present invention, an architectural structure comprises two inclined outer peripheral tube frame connected in a X-shape or a Δ -shape; in which each of two inclined outer peripheral tube frame rigidly connects the hexagon structural unit in a honeycomb-shape to form the main frame.

[0029] According to an aspect of the present invention, an architectural structure comprises an inclined inner tube frame as the main frame in which a second hexagon structural unit is rigidly connected in the honeycomb-shape, in the inside of each of two inclined outer peripheral tube frames.

[0030] This summary of the present invention does not necessarily describe all necessary features so that the invention may also be a sub-combination of these described features.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

Fig.1A is the appearance perspective view of one example of an architectural structure according to the present embodiment.

Fig.1B is the partial enlarged view of one example according to the present embodiment.

Fig.1C is the plan view of one example according to the present embodiment.

Fig.2A is the explanatory view of an analysis on a structure to compare the present invention with a conventional technology.

Fig.2B is a view showing the result to compare deformation between the present invention and the conventional technology.

Fig.2C is a view showing the result to compare a member related to deformation between the present invention and the conventional technology.

Fig.2D is a view showing the result to compare stress on a horizontal load between the present invention and the conventional technology.

Fig.3 is a view of one example of the architectural structure according to the present embodiment.

Fig.4 is a view of one example of the architectural structure according to the present embodiment.

Fig.5 is a view of one example of the architectural structure according to the present embodiment.

Fig.6 is a view of one example of the architectural structure according to the present embodiment.

Fig.7 is a view of one example of the architectural structure according to the present embodiment.

Fig.8 is the view of one example having pillars placed in the inside of the architectural structure according to the present embodiment.

Fig.9 is the appearance perspective view of one example having the pillars placed in the inside.

Fig.10 is the appearance perspective view of one example having an inner tube frame.

Fig.11 is the appearance perspective view of one example having the inner tube frame in the architectural structure according to the present invention.

Fig.12 is the appearance perspective view of one example having the inner tube frame.

Fig.13 is the appearance perspective view of one example having the inner tube frame.

Fig.14 is the appearance perspective view of one example having the inner tube frame.

Fig.15 is the appearance perspective view of one example having the inner tube frame.

Fig.16 is the appearance perspective view of one example having the inner tube frame.

Fig.17 is the appearance perspective view of one example having a dome-shaped part at the top.

Fig.18 is the appearance perspective view of one example having a tube width shift part at one part of an outer peripheral tube frame.

Fig.19 is an appearance perspective view showing one example of an extension architectural structure comprising a plurality of architectural structures having the outer peripheral tube frame in Figs.1A to 18.

Fig.20A is the appearance perspective view of the architectural structure having two inclined outer peripheral tube frame connected in an X-shape.

Fig.20B is a brief cross sectional view in a horizontal direction at a part to connect the inclined outer peripheral tube frames.

Fig.21 is a view showing sub frame provided in the architectural structure or the extension architectural structure shown in Figs.1A to 20.

DETAILED DESCRIPTION OF THE INVENTION

[0032] The invention will now be described based on preferred embodiments, which do not intend to limit the scope of the present invention, but rather to exemplify the invention. All of the features and the combinations thereof described in the embodiments are not necessarily essential to the invention.

[0033] Figs. 1A to 1C show one embodiment of an architectural structure according to the present invention, Fig. 1A is an appearance perspective view. Fig. 1B is a partial enlarged view. Fig. 1C is a plan view.

[0034] Fig. 1A is an outer peripheral tube frame 1, which is the main frame of an architectural structure. The outer peripheral tube frame 1 has a cylinder, namely a tube-shape. The cylinder in the tube-shape is formed by rigidly connecting a hexagon structural unit in a honeycomb-shape. The hexagon structural unit is comprised of six edges. The axis of a tube extends in a perpendicular direction. The main frame is the main part of a structure and an essential main part on structural resistance. Each edge of the hexagon structural unit is the structural element of the main frame. The element is a pillar, a beam or a partial part of a slab. In an example shown in the figure, all edges of the hexagon structural unit are comprised of the pillar and the beam. In an example shown in the figure, the cylinder is an angular cylinder. However, the cylinder may be a circular cylinder.

The architectural structure according to the present invention is basically formed by the hexagon structural unit in which the overall outer peripheral tube frame 1 is connected in the honeycomb-shape. Within the scope of the present invention or an allowable scope on a structural dynamic, however, the scope of the present invention includes structures to incorporate structures except for the hexagon structural unit into one part of the outer peripheral tube frame 1.

[0035] Fig. 1B shows the enlarged figure of one part of the outer peripheral tube frame 1 in Fig. 1A. One hexagon structural unit 10 places, members comprising the main frame, at six edges of a lower edge 11, an upper edge 12, a lower-left edge 13, an upper-left edge 14, a lower-right edge 15, and an upper-right edge 16. A hexagon lattice is formed by connecting members. Further, circumference of one hexagon structural unit 10 is surrounded by six hexagon structural units in the same shape. Each edge is shared with the hexagon structural unit which is adjacent to each edge. One-second of the height of the hexagon structural unit is shifted between a column and b column. a column is comprised of a plurality of hexagon structural units connected along a perpendicular direction G. b column next to a column is comprised of a plurality of hexagon structural units connected along the perpendicular direction G. a column and b column are alternately arranged along circumference of the tube.

[0036] The hexagon structural unit 10 has a shape in which the left side and the right side are symmetric. Two

inclined pillars are inclined in an opposite direction along the perpendicular direction G. The right edge comprises the lower-right edge 15 and the upper-right edge 16. The lower-right edge 15 and the upper-right edge 16 are connected and arranged in the hexagon structural unit 10. The lower-right edge 15 and the upper-right edge 16 are two inclined pillars. The lower-right edge 15 is inclined at a - α angle with respect to the perpendicular direction G. The upper-right edge 16 is inclined at an α angle with respect to the perpendicular direction G. The left edge is comprised of the lower-left edge 13 and the upper-left edge 14. The lower-left edge 13 and the upper-left edge 14 are inclined similar to the lower-right edge 15 and the upper-right edge 16.

[0037] In an example shown in Fig. 1C, the plane-shape of the outer peripheral tube frame 1 is almost quadrilateral. The face of the hexagon structural unit 10 placed at the four corners in the plane-shape is directed to the vertex of quadrilateral. Therefore, four corners of the plane-shape is a notched-shape. The plane-shape of the outer peripheral tube frame 1 may be circular or any of polygons. Also, the plane-shape may be a shape which includes a concave portion.

[0038] In an example of the hexagon structural unit 10 can be comprised of the pillar and the beam. Edges of the lower-left edge 13, the upper-left edge 14, the lower-right edge 15, and the upper-right edge 16 are inclined pillars as mentioned above. The lower edge 11 and the upper edge 12 are the beam or one part of the slab. Each of pillars is rigidly connected. The pillar and the beam are rigidly connected. The pillar and one part of the slab are rigidly connected. Each of pillars can be connected by known various ways. The pillar and the beam can be connected by known various ways. The pillar and one part of the slab can be connected by known various ways.

[0039] The lower edge 11 and the upper edge 12 may be the beam. The lower edge 11 and the upper edge 12 may be one part of the slab. One of the lower edge and the upper edge 12 may be the beam and the other may be one part of the slab. One part of the slab is, e.g., the end part of the slab (refer to Fig. 4 as mentioned hereinafter). When the slab protrudes from the outer peripheral tube frame 1 as a cantilever, one part of the slab is the base of the protruding portion.

[0040] The slab used as the main frame may be either a flat slab or a slab having the beam. Another embodiments as mentioned hereinafter are the same. It is preferable to use the flat slab not having the beam in light of a space is free without limitations.

[0041] The scale of the hexagon structural unit 10 can be set variously. For example, the height of the hexagon structural unit 10 is height of the story for one layer of the building. However, the height of the hexagon structural unit 10 is height of the story for two layers or four layers of the building. Thereby, it is preferable that the space is highly free. The hexagon structural unit 10 is not necessary to be a regular hexagon. Each of four edges placed at the left and the right is the same length. The upper

edge is also the same length as the lower edge.

[0042] Figs.2A to 2D show the result of comparison of two structural models corresponding to the present invention and a conventional technology. Referring to Fig. 2A to 2B, the structural feature of the architectural structure according to the present invention will be described below. The architectural structure has the outer peripheral tube frame shown in Fig. 1A. Fig.2A is the condition explanatory of a structural analysis to compare the present invention to the conventional technology. Fig.2B shows the result of a comparison deformed by a horizontal load. Fig.2C shows the result of comparison of members which relate to deformations. Fig.2D shows the result of comparison of stress the horizontal load.

[0043] Generally, the structure of a tube frame is highly stable. The tube frame is a frame in which a large number of pillars (the beam or one part of the slab is inclined) are arranged on an outer peripheral portion in balance. Earthquake-resistance and wind pressure-resistance of the tube frame are superior. The architectural structure according to the present invention has not only the characteristic of the conventional tube frame but also the following effect. That is, all pillars are inclined pillars and the inclined pillars are continuously connected in upper and lower directions. Thereby, it is possible to bear a perpendicular load for a long term. In addition, it is possible to bear an external horizontal load for a short term effectively. That is, the inclined pillars serve both pillars and braces at the same time.

[0044] In the outer peripheral tube frame comprised of the hexagon structural unit, the stress of bending moment, which occurs on the pillar and the beam (or one part of the slab) due to a load is smaller than that of the tube frame. The tube frame is a general rahmen frame comprised of a vertical pillar and a horizontal beam.

[0045] In Fig.2A, (A) is a structural model, a hexagon tube frame, of the outer peripheral tube frame in which the hexagon structural unit of the present invention is rigidly connected in a honeycomb-shape. (B) is a general rahmen frame model, namely "a stud tube frame". The general rahmen frame is comprised of the vertical pillar and the horizontal beam. Conditions of a hexagon tube frame and a stud tube frame are the same. The conditions are the plane-shape (outer peripheral portion of 52.3m), a plane dimension (area of 193.1m), and dimension of the height (6m x 5 layers=30) of the overall structure model. The number of points of intersection of the pillar and the beam is the same in each of the models. The hexagon tube frame is a frame in which each pillar of a stud tube frame is inclined as shown in Fig.2A.

[0046] In the first structural analysis, deformation is compared in a case where the pillar and the beam are members of the same dimension of RC-500mm X 500mm, as shown in Fig.2B. In detail, a horizontal force, which is necessary for a structural first design is applied and deformation is analyzed. In the result of analysis, a numeral is shown in Fig 2B. Deformation of the stud tube frame of (B) is 50mm at the maximum. Deformation of

the hexagon tube frame of (A) is 34mm at the maximum. Therefore, the deformed volume of the hexagon tube frame is smaller and the structure of the hexagon tube frame is stronger than that of the stud tube frame.

[0047] In the second structural analysis, the sectional dimension of members of the pillar and beam are compared in a case where the angle of the deformation of both frames is one-two hundred fifty as shown in Fig.2C. As a result, dimensions both the pillar and the beam of the stud tube frame of (B) are RC-550mm X 550mm, as shown at the bottom in Fig.2C. In contrast, dimensions both the pillar and the beam of the hexagon tube frame of (A) are RC-500mm X 500mm. Therefore, in a case where the structure is almost the same strength, the sectional dimensions both the pillar and the beam of the hexagon tube frame are smaller than those of the stud tube frame and the total volume of the structure of the hexagon tube frame can be reduced.

[0048] In the third structural analysis, stress between the stud tube frame and the hexagon tube frame under the same condition is compared as shown in Fig.2D. Fig. 2D shows bending moment of each pillar and each beam at the right side of each tube frame. A typical numeral is shown in moment figures shown at the right bottom of each figure. As a result of analysis, the pillar of the stud tube frame of (B) is 277kN · m and the beam is 393kN · m. In contrast, the pillar of the hexagon tube frame of (A) is 190kN · m and the beam is 365kN · m. Therefore, bending moment, stress in both the pillar and the beam of the hexagon tube frame is smaller. The hexagon tube frame can be comprised of smaller members, and the total volume of the structure can be reduced.

[0049] From the above result, the structure of the outer peripheral tube frame formed by rigidly connecting the hexagon structural unit in the honeycomb-shape is stronger than that of the tube frame of the general rahmen frame comprised of the vertical pillar and the horizontal beam. Earthquake-resistance and wind pressure-resistance of the outer peripheral tube frame are superior. Under the same strength condition, the total volume of the structure of the outer peripheral tube frame formed by rigidly connecting the hexagon structural unit in the honeycomb-shape can further be reduced than that of the tube frame of the general rahmen structure. Thereby, materials and minerals can be reduced. Further, the cost of the structure can be reduced.

[0050] The architectural structure of the present invention can be erected by various structural materials. Various structural materials are wooden construction, reinforced construction, RC construction, SRC construction, CFT construction, and prestressed concrete construction.

[0051] Referring to Figs. 3 to 21, various embodiments of the architectural structure in the present invention will be described, below.

[0052] Similarly to Fig. 1A, the architectural structure in Fig. 3 is provided with the outer peripheral tube frame 1 comprised of the pillar and the beam. A plurality of slabs

21a and 21 b are provided in the inside of the outer peripheral tube frame 1. In the hexagon structural unit of a column connected in the perpendicular direction, slabs 21a are respectively connected to beams 11a of the upper edge and the lower edge. On the other hand, in the hexagon structural unit in b column next to a column, the slabs 21b are respectively connected to beams 11b of the upper edge and the lower edge. Therefore, the slab 21a in a column and the slab 21b in a b column are placed such that the only distance of one-second of the height of the hexagon structural unit is spaced in a height direction.

[0053] In Fig.3, the plane-shape of the slab 21a connected to the beam 11a of the hexagon structural unit of a column is notched such that the end portion 21a2 of the slab 21a is directed backward from the face of the hexagon structural unit in b column. The plane-shape of the slab 21b connected to the beam 11b of the hexagon structural unit of b column is notched such that the end portion 21b2 of the slab 21b is directed backward from face of the hexagon structural unit of a column.

[0054] The architectural structure in Fig.4 provides with the outer peripheral tube frame 2 comprised of the pillar and one of the slab. In this embodiment, there is no beam at the lower edge and the upper edge of the hexagon structural unit of a column connected in the perpendicular direction. The end portion 21a1 of the slab 21a provided in the inside is connected to the end portion of an inclined pillar at both left and right sides. Thereby, the lower edge and the upper edge of the hexagon structural unit are comprised. On the other hand, there is no beam at the lower edge and the upper edge of the hexagon structural unit in adjacent b column. The end portion 21b1 of the slab 21b provided in the inside is connected to the end portion of an inclined pillar at the both left and right sides. Thereby, the lower edge and the upper edge of the hexagon structural unit are comprised. The slab 21a of a column and the slab 21b of b column are alternately placed such that the only distance of one-second of the height of the hexagon structural unit is spaced in the height direction.

[0055] In Fig.4, the plane-shape of the slab 21a connected to the hexagon structural unit in a column is notched such that the end portion 21a2 is directed backward from the face of the hexagon structural unit in b column. The plane-shape of the slab 21b connected to the hexagon structural unit in b column is notched such that the end portion 21b2 is directed to backward from the face of the hexagon structural unit of a column.

[0056] The architectural structure in Fig.5 has the outer peripheral tube frame 1. A plurality of slabs 21a are provided in the inside of the outer peripheral tube frame 1. In the hexagon structural unit in a column connected in the perpendicular direction, slabs 21a are connected to the slabs 11a at the lower edge and the upper edge. On the other hand, in the hexagon structural unit of b column next to a column, the slabs are not connected to the slabs 11b of the lower edge and the upper edge.

[0057] Therefore, the height H of the hexagon structural unit is a distance between the slabs 21a. For example, if the distance between the slabs 21a is for four layers of the building, a space between the slabs 21a can be partitioned into four layers by a sub frame as mentioned hereinafter. The slabs 21a in Fig. 5 are provided. Each slab 21a in Fig.5 is provided over the overall cross section of the outer peripheral tube frame.

[0058] Similarly to Fig. 1A, the architectural structure in Fig. 6 is provided with the outer peripheral tube frame 1 comprised of the pillar and the beam.

A plurality of slabs 21a and 21b are provided in the inside of the outer peripheral tube frame 1. In the hexagon structural unit in a column connected in the perpendicular direction, the slabs 21a are connected to the beams 11a of the upper edge and the lower edge. On the other hand, in the hexagon structural unit of b column next to a column, the slabs 21b are connected to the slabs 11b of the lower edge and the upper edge. Therefore, one-second of height H of the hexagon structural unit is a distance between the slab 21a and the slab 21b. The distance between the slab 21a and the slab 21b is for two layers of the building. A space between the slab 21a and the slab 21b can be partitioned into two layers by using the sub frame as mentioned hereinafter. The slab 21a and the slab 21b in Fig.6 are provided over the overall section of the outer peripheral tube frame.

[0059] Similarly to Fig. 1A, the architectural structure in Fig. 7 is provided with the outer peripheral tube frame 1 comprised of the pillar and the beam.

A plurality of slabs 21a and 21b are provided in the inside of the outer peripheral tube frame 1. In the hexagon structural unit in a1 column connected in the perpendicular direction, the slabs 21a are connected to the beams 11a of the upper edge and the lower edge. On the other hand, in the hexagon structural unit in adjacent b1 column, the slabs 21b are connected to the beams 11a of the upper edge and the lower edge. Therefore, one-second of height H of the hexagon structural unit is the distance between the slab 21a and the slab 21b.

[0060] In Fig.7, the plane-shape of the slab 21a connected to the beam 11a of the hexagon structural unit in a1 column is appropriately notched such that the end portion 21a2 is directed backward from the face of the hexagon structural unit in b1 column at the left side. On the other hand, the end portion 21a3 of the slab 21a is positioned on the face of the hexagon structural unit in b2 column at the right side. The plane-shape of the slab 21b connected to the beam 11b of the hexagon structural unit in b1 column is appropriately notched such that the end portion 21b2 is directed backward from the face of the hexagon structural unit in a1 column at the right side. On the other hand, the end portion 21b3 of the slab 21b is positioned on the face of the hexagon structural unit in a2 column at the left side.

[0061] When the plane-shape of the slabs 21a and 21b is formed as aforementioned, the portion of height H of the hexagonal structural unit and the portion of one-second

ond of height H are alternately arranged on the face of the hexagonal structural unit in a1 column, in the distance between slabs.

[0062] The plane-shape of each slab in embodiments as shown in Figs.3 to 7 is one example. The edge of the slab, which serves as the lower edge or the upper edge itself on the hexagon structural unit can not be removed. This is because the edge are one part of the main frame. However, the plane-shape of another parts can be any shapes within the allowable scope on the structural dynamic.

[0063] The architectural structure of Fig.8 provides with a plurality of pillars placed in the inside 6, which extend in the perpendicular direction in the inside of the outer peripheral tube 1. The pillar placed in the inside 6 is the element in which a main frame is configured. The number of pillars placed in the inside 6 is one or plural and is not limited. However, it is preferable that the pillar placed in the inside 6 are arranged such that the pillars placed in the inside 6 are symmetric with respect to the center of the outer peripheral tube frame 1 when a plurality of pillars placed in the inside 6 are placed. The architectural structure of Fig.8 is the same as that in Fig.5 except for the pillars placed in the inside 6. The pillar placed in the inside 6 is provided such that the pillar placed in the inside pierces each slab 21a. The pillar placed in the inside 6 bears each slab 21a. The distance between the slabs 21a is the same as the height of the hexagon structural unit.

[0064] The architectural structure of Fig.9 is the other structure in which a plurality of pillars placed in the inside 6 are provided in the inside of the outer peripheral tube frame 1. The architectural structure of Fig.9 is the same as that in Fig.6, except for the pillars placed in the inside, and the distance between the slabs 21a is one-second height of the hexagon structural unit.

[0065] The architectural structure of Fig.10 comprises the inner tube frame 3 as the main frame in which a second hexagon structural unit 30 is rigidly connected in the honeycomb-shape. The second hexagon structural unit 30 also arranges two edges such that each of two inclined pillars is inclined in an opposite direction. Two edges are placed such that the left side and the right side are symmetric. The second hexagon structural unit 30 is formed such that any of the beam or one part of the slab is respectively provided at the upper edge and the lower edge along the horizontal direction. The pillar and the pillar are rigidly connected. The pillar and the beam are rigidly connected. The pillar and one of the slab are rigidly connected. The pillar and the pillar can rigidly be connected by known various ways. The pillar and the beam can rigidly be connected by known various ways. The pillar and one of the slab can rigidly be connected by known various ways.

[0066] The second hexagon structural unit 30 is not necessarily the same as the hexagon structural unit or a similarity figure. The outer peripheral tube frame 1 comprised of the hexagon structural unit. However, it is pref-

erable that the height of the second hexagon structural unit 30 is lower than that of the hexagon structural unit. In the example of Fig.10, the height of the second hexagon structural unit 30 is one-second of that of the hexagon structural unit. Further, it is preferable that the length of the lower edge and the upper edge of the second hexagon structural unit 30 is shorter than that of the hexagon structural unit. The length of each edge of the second hexagon structural unit 30 is shorter than that of the hexagon structural unit. Thereby, the structure is extremely strong. This is preferable as a core part, which bears the architectural structure. When the inner tube frame 3 is provided, a load to be shared is adjusted. Thereby, it is possible that the pillar or the beam becomes shorter than that in a case of bearing the architectural structure by the only the outer peripheral tube frame 1. The second hexagon structural unit 30 may not necessarily be a regular hexagon. However, each of four edges placed at the left side and the right side is the same length. The upper and the right edges are the same length.

[0067] The slab as the main frame may be provided in the inside of the inner tube frame 3. Thereby, a structure becomes further strong. The inside of the inner tube frame 3 is void. Thereby, it is possible to provide with an elevator, common facility pipe space, story, blowly and the like. It is possible to design the structure whether or not the elements of the main frame are provided in the inside of the inner tube frame 3. The structure can be designed depending on sharing the load with another main frames of the outer peripheral tube frame 1.

[0068] The architectural structure of Fig. 11 provides with the inner tube frames 3a, 3b, 3c and 3d in the inside of the outer peripheral tube frame 1. Four inner tube frames are respectively arranged at the four corners such that four inner tube frames are symmetric with respect to the center of the outer peripheral tube frame 1. Each of inner tube frames is provided such that each pierces a plurality of slabs 21 in the inside of the outer peripheral tube frame 1. The distance between a plurality of slabs 21 is the same as the height H of the hexagon structural unit of the outer peripheral tube frame.

[0069] The architectural structure of Fig.12 provides with the inner tube frame 3 at the center of the outer peripheral tube frame 1. The architectural structure of Fig.12 provides with the plurality of slabs 21 provided in the structure of Fig.10. The inner tube frame 3 pierces a plurality of slabs 21. The distance between a plurality of slabs 21 is the same as the height H of the hexagon structural unit of the outer peripheral tube frame.

[0070] The architectural structure of Fig.13 provides with the inner tube frame 3 at the center of the outer peripheral tube frame 1. The architectural structure of Fig.13 provides with a plurality of slabs 21 provided in the structure of Fig.10. The inner tube frame 3 pierces a plurality of slabs 21. The distance between a plurality of slabs 21 is one-second of the height H of the hexagon structural unit of the outer peripheral tube frame.

[0071] The architectural structures of Fig.14 and 15

provides with the inner tube frame 3 at the center of the outer peripheral tube frame 1. The shape of the slabs is modified. The slabs are provided in the inside of the outer peripheral tube frame 1.

[0072] The architectural structure of Fig.16 provides with the inner tube frame 3 at the center of the outer peripheral tube frame 1. In Fig.16, the end portion 21a1 of the outside of the slab 21a is connected to the beam 11a of the outer peripheral tube frame 1. On the other hand, the end portion 21a4 of the inside of the slab 21a is connected to the pillar of the second hexagon structural unit in the inner tube frame 3. Thereby, the lower edge of the second hexagon structural unit is configured. In Fig.16, the outer peripheral tube frame 1 is connected to the inner tube frame 3 via the slab 21a and is unified into one.

[0073] In one embodiment of another embodiments, the outer peripheral tube frame may be connected to the inner tube frame via the beam as the main frame (not shown in Figure).

[0074] In one embodiment of another embodiments, the slab connected to the outer peripheral tube frame may be crossed the inner tube frame (not shown in Figure).

[0075] The architectural structure of Fig.17, a plurality of pentagon structural units 40 are inserted on the top of the outer peripheral tube frame 1. Thereby a rounding dome-shaped part 4 is formed. The dome-shaped part 4 closes the top of the tube. In Fig.17, the pentagon structural unit 40 is inserted every one column along the circumference of the tube. As shown in Fig. 17, the top of the tube can be closed by inserting the pentagon structural unit appropriately. The top of the tube can be closed, not only in a case where the plane-shape of the outer peripheral tube frame 1 is circular but also in a case where the plane-shape of the outer peripheral tube frame 1 is a shape (polygon etc.) except for circular.

[0076] The architectural structure of Fig.18, a plurality of pentagon structural units 50 are inserted on one part of a central direction of the outer peripheral tube frame 1. Thereby, the architectural structure has a tube width shift part 5 to reduce a tube width. In Fig.18, vertex of each of two pentagon structural units 50 is junt-joined along the top and the bottom directions. The junt-joined part is inserted every one column along the circumference direction of the tube. The tube width is a diameter in the case where the plane-shape is circular. The tube width is the average diameter or extension width etc. in a case where the plane-shape is a shape (polygon etc.) except for circular. The tube width on the upper part of the tube width shift 5 is narrower than that at the lower part. This structure is preferable to reduce the load of the upper layer in the high-rise or the super high-rise building. The tube width shift part 5 may be provided at a plurality of points along the center of one outer peripheral tube frame.

[0077] Fig.19 is an appearance perspective view showing one embodiment of an enlarged architectural

structure comprised of a plurality of the architectural structures of any of the architectural structures having the outer peripheral tube frame as described in Figs.1A to 18. In Fig.19, four architectural structures 1a, 1b, 1c, and 1d are placed at four corners such that each of four structures is spaced each other. Four architectural structures 1a, 1b, 1c, and 1d are connected by the plurality of slabs 24 as the main frame. In this embodiment, one architectural structure plays a role as one pillar in the extension architectural structure. Each of architectural structures may be connected via the beam.

[0078] As another embodiment of the extension architectural structure having a plurality of architectural structures in Figs.1A to 18, the architectural structures are placed such that each architectural structures is adjacent. The architectural structures are connected such that one part, the hexagon structural unit, of the outer peripheral tube frame in each of two adjacent architectural structures is shared (not shown in Figure). The enlarged architectural structure is formed by connecting a plurality of architectural structures in a chain-shape.

[0079] The architectural structure in Fig.20A provides with two inclined outer peripheral tube frame 7a and 7b connected in an X-shape. The main frame is formed by connecting the hexagon structural unit 70 of each two inclined outer peripheral tube frames 7a and 7b in the honeycomb-shape. Fig.20B is the brief cross sectional view of a horizontal direction at a portion to connect two inclined outer peripheral tube frames 7a and 7b. The axis of each of tube frames 7a and 7b is inclined and extended in the perpendicular direction. The direction of the hexagon structural unit 70 is the same direction as the hexagon structural unit in the outer peripheral tube frame shown in Figs. 1A to 18. The hexagon structural unit 70 arranges two edges of two inclined pillars, inclined in an opposite direction, which are connected. Two inclined pillars are inclined in an opposite direction along the perpendicular direction. Two edges are placed such that the left side and the right side are symmetric. The hexagon structural unit 70 is formed such that any of the beam or one part of the slab is respectively provided at the upper edge and the lower edge along the horizontal direction. The pillar and the pillar are rigidly connected. The pillar and the beam are rigidly connected. The pillar and one of the slabs are rigidly connected. The pillar and the pillar can rigidly be connected by known various ways. The pillar and the beam can rigidly be connected by known various ways. The pillar and one of the slabs can rigidly be connected by known various ways.

[0080] Each of the tops of two inclined outer peripheral tube frames may be connected in a Δ -shape (not shown in Figure) in stead of connection of two inclined outer peripheral tube frames in the X-shape. A structure, in which two inclined outer peripheral tube frames are connected in the X-shape or Δ -shape, is a strong structure having excellent earthquake-resistance and wind pressure-resistance.

[0081] The architectural structure in Fig.20A further

comprises inclined inner tube frames 8a and 8b forming the main frame by rigidly connecting a second hexagon structural unit 80 in the honeycomb-shape in the inside of each of two inclined outer peripheral tube frames 7a and 7b, respectively.

The direction of the second hexagon structural unit 80 of each is the same direction as the second hexagon structural unit in the inner tube frame as shown Figs. 11 to 16. That is, the second hexagon structural unit 80 provides with two edges in which the inclined pillars are connected. Two edges are placed such that the left side and the right side are symmetric. Two inclined edges are inclined such that each of edges is inclined in the opposite direction, along the perpendicular direction. The second hexagon structural unit 80 is formed such that any of the beam or one part of the slab is respectively provided at the upper edge and the lower edge. The pillar and pillar, the pillar and the beam, the pillar and one of the slab is rigidly connected. The pillar and pillar, the pillar and the beam, the pillar and one of the slab can rigidly be connected by known various ways.

[0082] In a preferable embodiment, an inclined inner tube frame 8a is not overlapped with an inclined inner tube frame 8b in a point where the inclined outer peripheral tube frame 7a is connected to the inclined outer peripheral tube frame 7b. The inclined inner tube frame 8a is adjacent to the inclined inner tube frame 8b, or the inclined inner tube frame 8a and the inclined inner tube frame 8b are spaced. When the inclined inner tube frame 8a is adjacent to the inclined inner tube frame 8b, the inclined inner tube frame 8a is directly connected to the inclined inner tube frame 8b. When the inclined inner tube frame 8a and the inclined inner tube frame 8b are spaced, the inclined inner tube frame 8a is connected to the inclined inner tube frame 8b via the slab or the beam as the main frame. The slab or the beam as the main frame may be provided in the inside of the inclined inner tube frames 8a and 8b. The inside of the inclined inner tube frames 8a and 8b is void. Thereby, the elevator or common facility pipe space may be provided in the inside of the inclined inner tube frames 8a and 8b.

[0083] Fig. 21 shows briefly a structure in which sub frames 25a, 25b and 25c are provided in the inside of the outer peripheral tube frame or the inclined outer peripheral tube frame in the architectural structure or the extension architectural structure as shown in Figs. 1A to 20. The slab 21 of the main frame is provided at the same interval as the height of the hexagon structural unit in (A). This interval of the slab corresponds to for four layers of the building. Therefore, a space between the slabs 21 of the main frame is participated into four layers, by three sub frames 25a, 25b and 25c.

[0084] As shown in Fig. 21 (B), the slabs 21 are provided at the upper edge and the lower edge of the hexagon structural unit. When the height of the hexagon structural unit is for four layers, all or one part of three sub frames 25a, 25b and 25c can be separated or connected. Convexes 26a, 26b and 26c to receive the sub

frames are provided in the inside of the inclined pillar at the both right and left edges of the hexagon structural unit.

[0085] As shown in Fig.21(C), the slab 21 of the main frames is provided at the center of height of the hexagon structural unit. When the height of the hexagon structural unit is for four layers, all or one of two sub frames 25a and 25c can be separated or connected.

[0086] The sub frame is one part of a structure to bear partitioned each layer structurally. However the sub frame does not necessary have earthquake-resistance and wind pressure-resistance. Therefore, it is possible to appropriately separate and connect the sub frames. By using the sub frame, two dimensional and three dimensional spaces are highly free.

[0087] In an architectural structure having a basic structure of the present invention, an outer peripheral tube frame of a main frame is formed by rigidly connecting a hexagon structural unit in a honeycomb-shape. The main frame configures the main part of a structure and is the essential main part on the bearing force of the structure. The shape of each hexagon structural unit is a hexagon lattice- shape. When the hexagon structural units are rigidly connected in the honeycomb-shape, each edge of a hexagon lattice is shared with each edge of the adjacent hexagon lattice. The overall rigidly connected in the honeycomb- shape is a cylinder-shape, and thereby an extremely strong tube frame can be implemented. Each of the hexagon structural unit is configured by the member of the main frame, e.g., a pillar or one part of a slab. As mentioned above, the outer peripheral tube frame formed by the hexagon structural unit in the present invention, the beam (or one part of the slab) is not continuous in a horizontal direction. Pillars are configured by inclined pillars continuously in a zigzag-shape. These features are absolutely different from the tube frame of a conventional rahmen frame. The peripheral face of the tube frame in an outer peripheral tube frame comprising the hexagon structural unit of the present invention is formed by a honeycomb structure. This feature is different from that of a conventional hexagon tube frame. The hexagon tube frame provides with the honeycomb structure in a conventional horizontal plane and is stacked in a perpendicular direction via a stud.

[0088] As the main frame of a high-rise and super high-rise buildings, the only outer peripheral tube frame can obtain stability and earthquake-resistance of the structure of the overall building, in the architectural structure of the present invention. That is, it is not necessary to provide with a double tube, a diaphragm in a slab-shape in the inside, or a bearing pillar in the inside such as an aforementioned conventional technology. Thereby, the volume of a member can be reduced, construction time can be shortened, and a free inner space can be obtained. A connection structure in the honeycomb-shape of the hexagon unit is different in a technological field. However, there is a feature in common with that of a connection structure which each of a carbon in a nanote-

chnology is strongly connected. The carbon nanotube has a structure which a carbon atom is connected in a honeycomb- shape and the overall is a cylindrical-shape. The carbon nanotube is highly stable extremely on bend or tensile.

[0089] In the architectural structure of the present invention, a tube frame has a great bearing force on a horizontal load from any directions. The tube frame keeps a connection, of all pillars and beams (or one part of the slab) in the outer peripheral tube frame comprised of the hexagon structural unit, stable in balance. As a result, a stress which occurs at the point connecting the pillar and the beam (or one part of the slab) by a load is smaller than the stress of the outer peripheral tube frame of a general rahmen frame. This is because one part of a bent stress is transformed to the axis force of a member (inclined column, beam, or the like) to be propagated. The member of a general RC etc. is strong on a compressed force. Thereby, this is an advantage to bear the axis force.

[0090] As a result of a structural analysis, deformation on the same horizontal load of the outer peripheral tube frame comprised of the hexagon structural unit is smaller than that of the conventional outer peripheral tube frame comprised of the general rahmen frame having a stud and a horizontal beam. The hexagon structural unit is rigidly connected in the honeycomb-shape of the present invention. Therefore, in the outer peripheral tube frame of the present invention, it is possible to use a pillar and a beam thinner than those of the conventional outer peripheral tube frame on the horizontal load, which occurs the same deformation. As a result, the total volume and the cost of the structure can be reduced.

[0091] As a result of a structural analysis, a bending moment in which the horizontal load acts on each edge of the structural unit is smaller than that of the outer peripheral tube frame comprised of the conventional general rahmen frame having the stud and the horizontal beam. Thereby, the load is reduced. When the same bending moment is generated, it is possible to use the pillar and the beam thinner than those of the conventional outer peripheral tube frame. As a result, the total volume and the cost of the structure can be reduced.

[0092] Two inclined pillars are continuously connected along the perpendicular direction in the zigzag-shape. Two inclined pillars are placed at the right side and two inclined pillars are placed at the left side of the hexagon structural unit. Two inclined pillars play a roll as the pillar and a brace. Two inclined pillars efficiently bear a perpendicular load for a long term. Further, two inclined pillars bear an external load for a short term, like a horizontal direction except for the perpendicular direction.

[0093] All portions of members configured on the face of the outer peripheral tube frame are linear member structures, and thereby an opening is easily provided.

[0094] Basically, a structure is comprised of a large number of hexagon structural units in the same shape, thus the size and the shape of all studs and all beams can be unified into one kind or various kinds. Thereby,

construction can be improved, construction time can be shortened, and the cost can be reduced.

[0095] The hexagon structural unit is predetermined united to be the structure of prestressed concrete construction as a precast concrete. Thereby, construction can be improved, construction time can be shortened, and the cost can be reduced.

[0096] The honeycomb structure comprised of the hexagon structural unit is used as the outer peripheral tube frame. This makes building's visual beautiful.

[0097] A plurality of slabs as the main frame are provided at the same interval as height of the hexagon structural unit. In an another embodiment, a plurality of slabs as the main frame are provided at the same interval as one-second height of the hexagon structural unit. The overall architectural structure can highly be strong by providing with the slabs as the main frame. As a result, the load of the outer peripheral tube frame can be reduced. Size of the pillar or the beam of the outer peripheral tube frame can appropriately be thin. When another elements of the main frame added to the outer peripheral tube frame are added, the rate of the load can be adjusted by a design and size etc. of a used member can be adjusted.

[0098] An architectural structure provides with a sub frame to partition, a space between slabs, into four layers. An architectural structure provides with the sub frame to partition, the space between slabs, into two layers. The sub frame is also one part of a structure. Mainly, the sub frame is to bear each layer. It is not necessary to have earthquake-resistance and wind pressure- resistance. Therefore, the sub frame can be connected at any positions between slabs of the main frame and can be separated from any positions between slabs. Thereby, two dimensional and three dimensional spaces are highly free.

[0099] When height of the hexagon structural unit is height of stories for four layers of the building, actually the beam is alternately provided every two layers (because the only one-second of height of the unit is shifted. The shift of the height is between the column of a plurality of hexagon structural units and a column next to the column of a plurality of hexagon structural units). Therefore, it is easily to provide with the space of two layers or four layers in the main frame.

[0100] An architectural structure mixes two portions. One portion has a plurality of slabs as the main frame at the same interval as the height of the hexagon structural unit. The other portion has a plurality of slabs as the plurality of main frames at the same interval as one-second height of the hexagon structural unit. In this case, there are the same effects and there is a further advantage that an inner design is highly variety.

[0101] An architectural structure comprises one or a plurality of pillars placed in the inside, as the main frame extended in the perpendicular direction in the inside of the outer peripheral tube frame. Thereby, the strength of the architectural structure can highly be improved. Especially, the strength on the perpendicular load for the

long term can be improved. As a result, the load of the outer peripheral tube frame can be reduced and size of the pillar or the beam of the outer peripheral frame can appropriately be thin.

[0102] An architectural structure comprises one or a plurality of inner tube frames comprised of a second hexagon structural unit in the inside of the outer peripheral tube frame. Thereby, the architectural structure is a double tube frame. The inner tube frame is formed by rigidly connecting the second hexagon structural unit in the honeycomb-shape, like the outer peripheral tube frame. Thereby, the inner tube is highly strong. The hexagon structural unit and the second hexagon structural unit do not always have the same shape. By providing with the inner tube frame, the architectural structural is highly strong. As a result, the load of the outer peripheral tube frame can be reduced and size of the pillar or the beam of the outer peripheral tube frame can appropriately be thin.

[0103] The height of the second hexagon structural unit of the inner tube frame is one-second height of the hexagon structural unit of the outer peripheral tube frame. Height of the second hexagon structural unit is shortened, and hereby the inclined pillar of corresponding each edge is also shortened. Thus, the structure becomes further strong against bend or tensile. In addition, the slab or the beam is easily provided in a position (a lower edge or an upper edge are positioned at the same horizontal position) in which the hexagon structural unit is matched to the second hexagon structural unit in a perpendicular direction.

[0104] The outer peripheral tube frame and the inner tube frame are connected via the slab or the beam as the main frame. Thereby, the overall architectural structure can highly be strong.

[0105] The architectural structure comprises the slab as the main frame in the inside of the inner tube frame. Thereby, the inner tube frame can highly be strong.

[0106] Inside of the inner tube frame is void. Thereby, various structural elements can be placed. For example, an elevator, a common use facility pipe space, a story, or blowby is freely provided. In the architectural structure of the present invention, the only outer peripheral tube frame can bear the overall. Therefore, a free space in the inside of a core part is highly provided.

[0107] The slab as the main frame may be either a flat slab or a slab having a beam. The advantage of the flat slab is that the dwelling does not have the beam. Also, the advantage of the slab having the beam is that the slab can be thin.

[0108] An architectural structure comprises a dome-shaped part in which a plurality of pentagon structural units are inserted at the top of the outer peripheral tube frame. Thereby, the top of the building can be closed in a round dome-shape. A design can be variety. The inserted portion of the pentagon structural unit is connected to the hexagon structural unit in a state where bias or stress exerting a bad influence does not occur. There-

fore, there is no problem on strength of the structure.

[0109] The architectural structure provides with a tube width shift part in which a plurality of pentagon structural units are placed on one part of the central direction of the outer peripheral tube frame. Thereby, width of the outer peripheral tube frame can be reduced from a bottom to a top. For example, to reduce a load from an upper layer part in the high-rise or the super high-rise building, it is useful that the tube shift part is provided and the upper layer part is reduced. The design can be variety. When a plane-shape is a circular tube, width of the outer peripheral tube frame corresponds to a diameter. When the plane-shape is the tube of polygon, width of the outer peripheral tube frame corresponds to a mean diameter or extension length. The inserted portion of the pentagon structural unit is connected to the hexagon structural unit in the state where bias or stress exerting the bad influence does not occur. Therefore, there is no problem on strength of the structure.

[0110] An extension architectural structure comprises a plurality of architectural structures. Each of architectural structures has structural strength as mentioned above. In addition, one part of each outer peripheral tube frame is shared each other and is connected. Thereby, the overall extension architectural structure is a structure having great earthquake-resistance and wind pressure-resistance against deformations by bend or twist due to a horizontal load.

[0111] An extension architectural structure comprising the plurality of the architectural structures. Each of architectural structures has the structural strength as mentioned above. In addition, each of architectural structures is connected by the beam or the slab as the main frame. Thereby, the overall extension architectural structure is a structure having great earthquake-resistance and wind pressure-resistance against deformations by bend or twist due to the horizontal load.

[0112] Two inclined outer peripheral tube frames in which the hexagon structural unit is rigidly connected in a honeycomb-shape are respectively connected in an X-shape or a Λ -shape. Thereby, the structure has great earthquake-resistance and wind pressure-resistance against deformations by bend or twist due to the horizontal load.

[0113] Inclined inner tube frames as the main frame are respectively provided in the inside of each of two inclined outer peripheral tube frames connected in an X-shape or a Λ -shape. The main frame is a frame in which the second hexagon structural unit is rigidly connected in the honeycomb-shape. Thereby, the structure can highly be strong. In addition, each of the inclined inner tube frames as the main frame is adjacent. Each of the inclined inner tube frames can be connected directly. Each of the inclined inner tube frames can be connected via the slab or the beam. Further, various structural elements such as an elevator or a common facility pipe etc. can be placed in the inside of the inner tube frame.

[0114] Although the present invention has been de-

scribed by way of exemplary embodiments, it should be understood that many changes and substitutions may be made by those skilled in the art without departing from the spirit and the scope of the present invention which is defined only by the appended claims.

Claims

1. An architectural structure comprising an outer peripheral tube frame as a main frame in which each edge of a hexagon structural unit having six edges is shared with an adjacent unit and each edge is rigidly connected to the adjacent unit in a honeycomb-shape; wherein the hexagon structural unit arranges two edges such that right and left are symmetric, two edges where two inclined pillars inclined in an opposite direction are connected, and any of a beam or one part of a slab is respectively provided at an upper side and a lower side along a horizontal direction.
2. An architectural structure as claimed in claim 1, comprising a plurality of slabs as a main frame at the same interval as height of the hexagon structural unit.
3. An architectural structure as claimed in claim 2, comprising a sub frame where a space between slabs are partitioned into four layers.
4. An architectural structure as claimed in claim 1, comprising a plurality of slabs as the main frame at the same interval as one-second height of the hexagon structural unit.
5. An architectural structure as claimed in claim 4, comprising a sub frame where a space between slabs are partitioned into two layers.
6. An architectural structure as claimed in claim 1, comprising a portion for having a plurality of slabs as the main frame at the same interval as height of the hexagon structural unit and a portion for having a plurality of slabs as a plurality of main frames at the same interval as one-second height of the hexagon structural unit.
7. An architectural structure as claimed in any of claims 1 to 6, comprising one or a plurality of pillars placed in the inside, as the main frame, extending in a perpendicular direction in the inside of the outer peripheral tube frame.
8. An architectural structure as claimed in any of claims 1 to 7, comprising one or a plurality of inner tube

frames as the main frame where a second hexagon structural unit is rigidly connected in a honeycomb-shape in the inside of the outer peripheral tube frame.

9. An architectural structure as claimed in claim 8, wherein height of the second hexagon structural unit is one-second of that of the second hexagon structural unit.
10. An architectural structure as claimed in claims 8 or 9, wherein the outer peripheral tube frame and the inner tube frame are connected via the slab or the beam as the main frame.
11. An architectural structure as claimed in any of claims 8 to 10, comprising the slab as the main frame in the inside of the inner tube frame.
12. An architectural structure as claimed in any of claims 8 to 10, wherein inside of the inner tube frame is void.
13. An architectural structure as claimed in any of claims 1 to 12, wherein the slab is a flat slab or a slab having a beam when the slab as the main frame is provided.
14. An architectural structure comprising a part in a dome-shape as claimed in any of claims 1 to 13, wherein a plurality of pentagon structural units are inserted at the top of the outer peripheral tube frame.
15. An architectural structure as claimed in any of claims 1 to 14, comprising a tube width shift part that a plurality of pentagon structural units are inserted at one part of the axis direction of the outer peripheral tube frame; wherein width of the outer peripheral tube frame at the upper part of the tube width shift part is narrower than that of the outer peripheral tube frame at a lower part.
16. An extension architectural structure as claimed in any of claims 1 to 15, comprising a plurality of the architectural structures where two adjacent architectural structures share with the hexagon structural unit of one part of each outer peripheral tube frame and two adjacent architectural structures are connected each other.
17. The extension architectural structure as claimed in any of claims 1 to 15, comprising a plurality of architectural structures where each of a plurality of architectural structures is spaced each other and is connected by a beam or the slab as the main frame.
18. An architectural structure comprising two inclined outer peripheral tube frame, as the main frame, connected in an X-shape or a Δ -shape; wherein each of two inclined outer peripheral tube frame rigidly connects the hexagon structural unit in a honey-

comb-shape.

19. An architectural structure as claimed in claim 18, comprising an inclined inner tube frame as the main frame in which a second hexagon structural unit is rigidly connected in the honeycomb-shape in the inside of each of two inclined outer peripheral tube frames.

5

10

15

20

25

30

35

40

45

50

55

Fig.1A

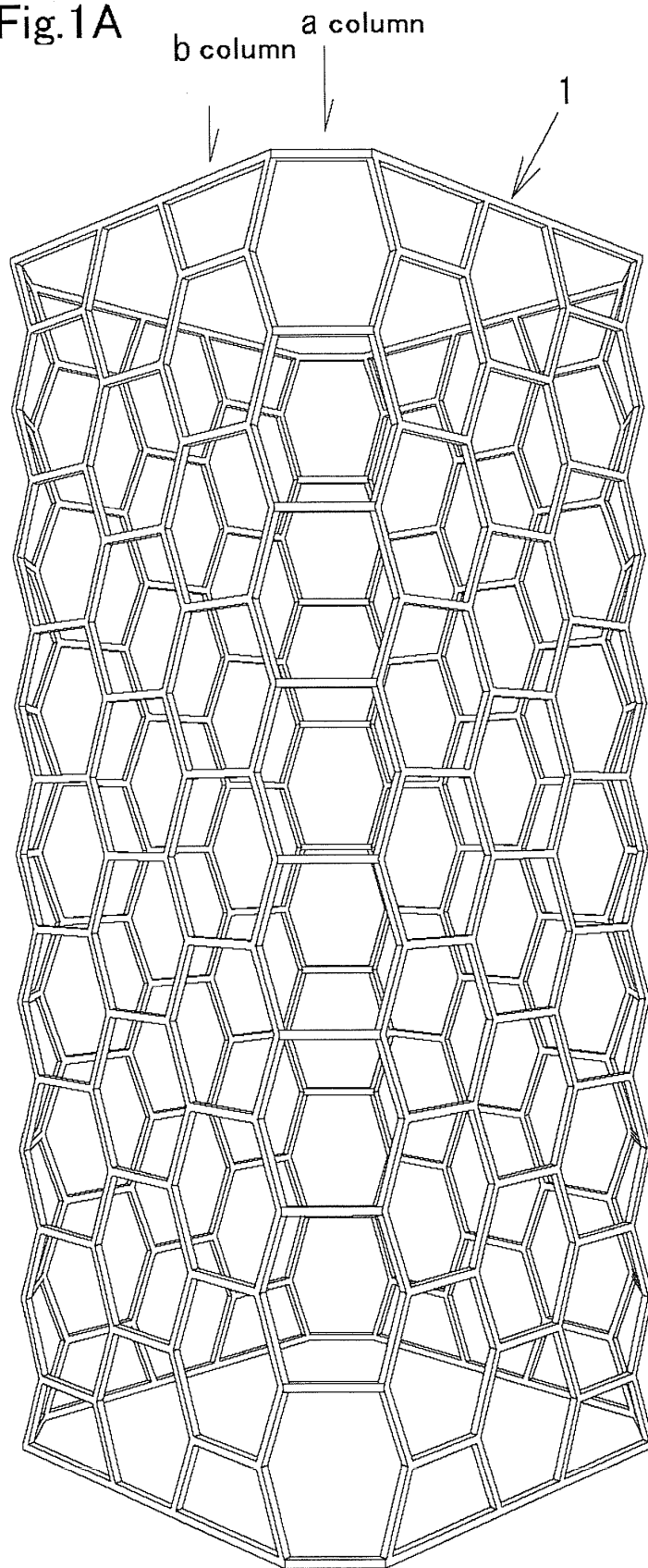


Fig.1B

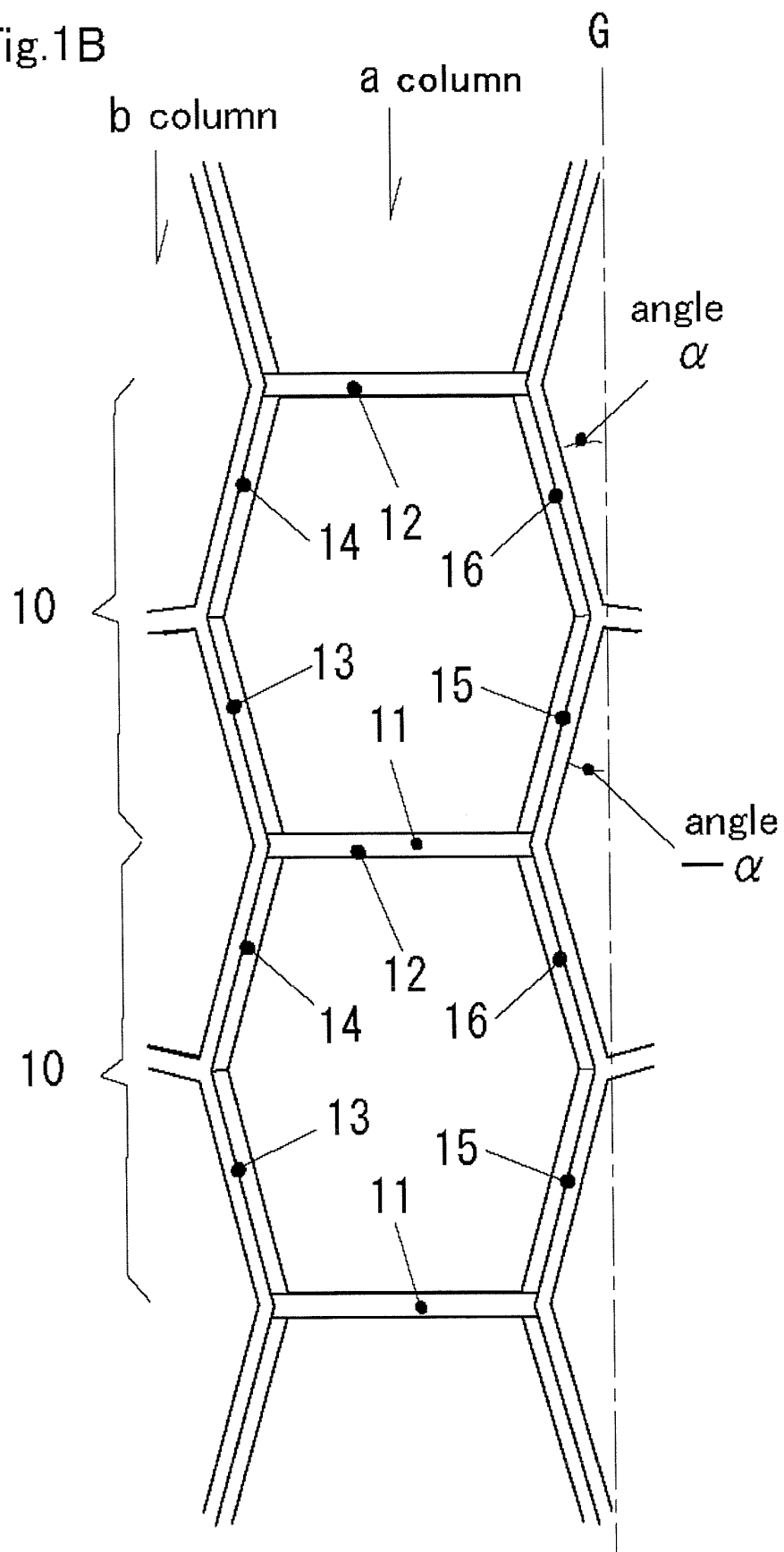


Fig.1C

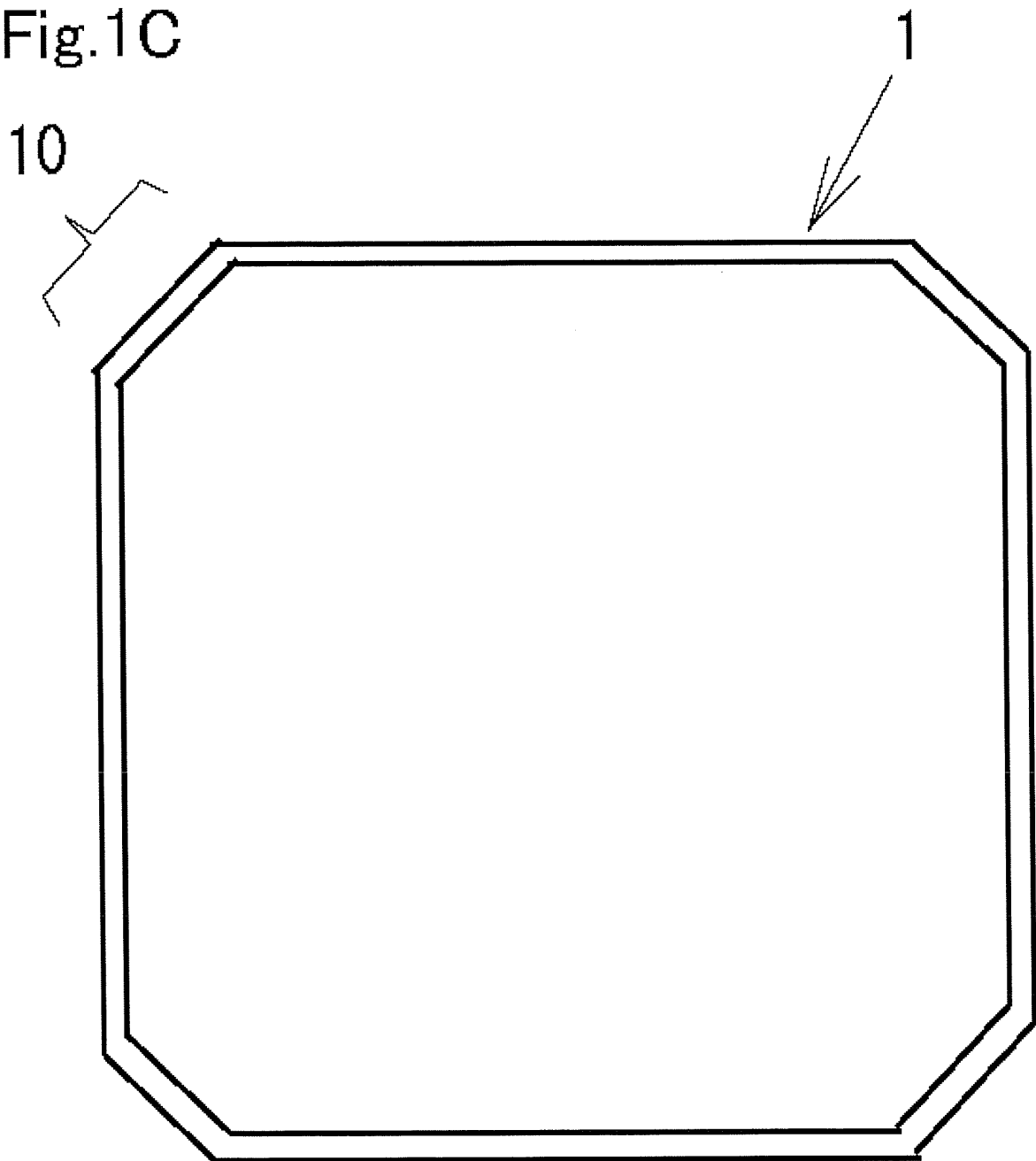
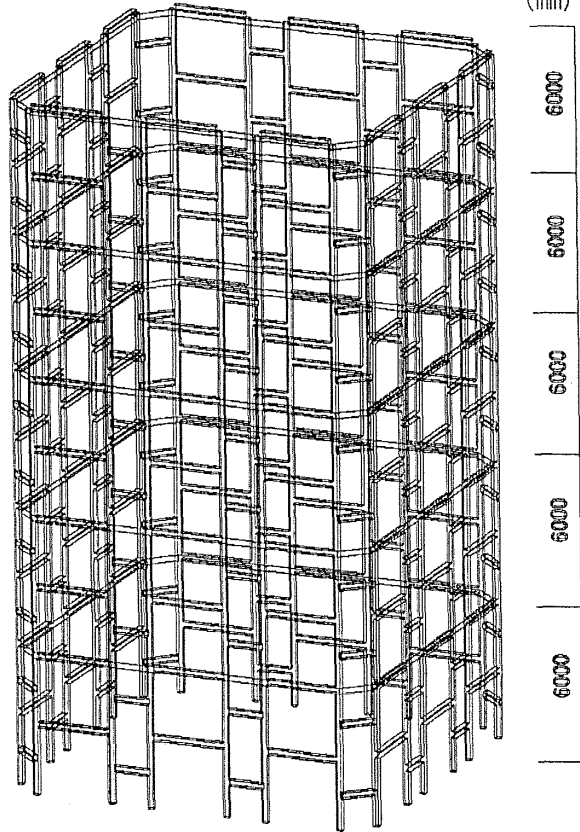
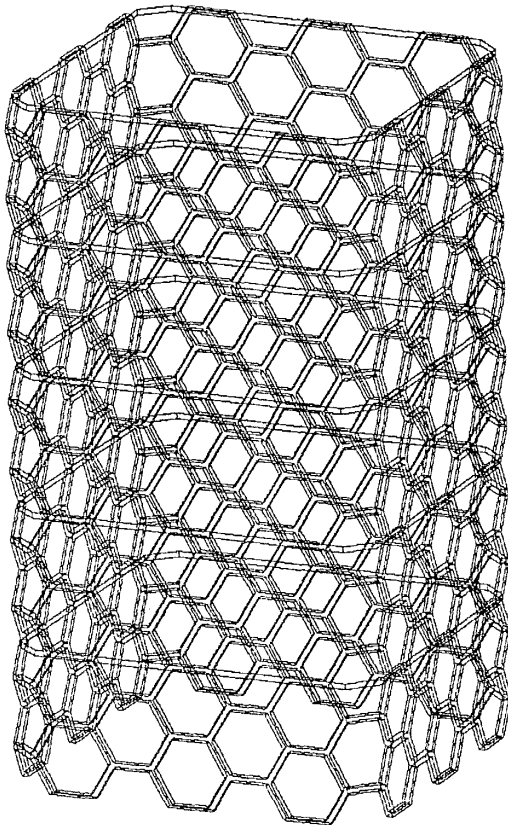


Fig.2A

< condition to analyze structure >

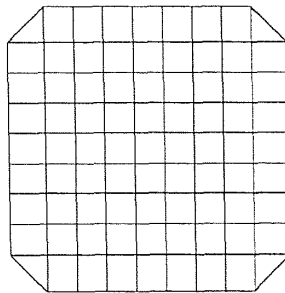
(A) hexagon tube frame

(B) stud tube frame



(C)

plane
view



area 193.1 m^2

outer
periphery
part 52.3m

height of story $6.0\text{m} \times 5 \text{ layers} = 30\text{m}$

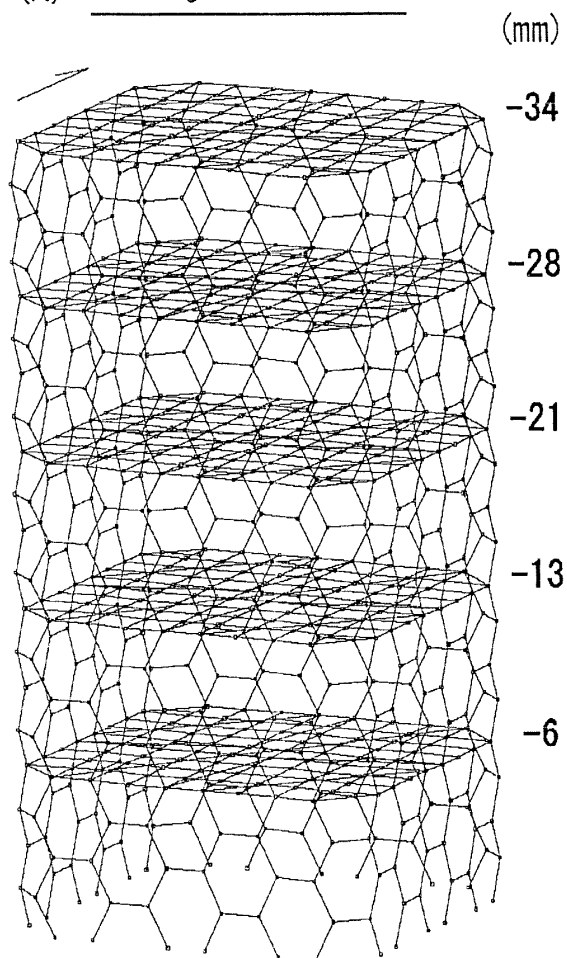
Fig.2B



comparison of deformation of
member in the same dimension



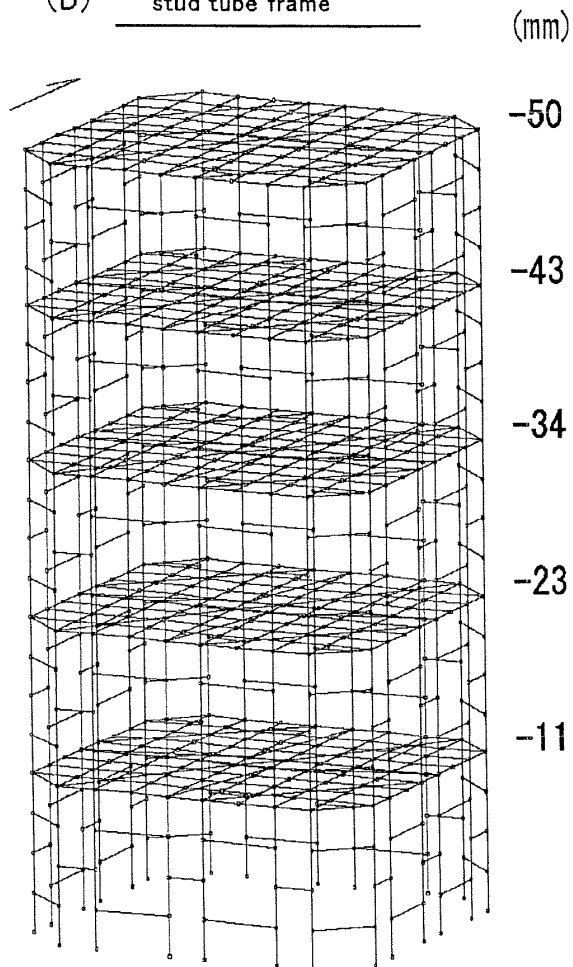
(A) hexagon tube frame



pillar RC ■ 500x500

beam RC ■ 500x500

(B) stud tube frame



pillar RC ■ 500x500

beam RC ■ 500x500

Fig.2C

< comparison of dimension of member
in almost same deformation

>

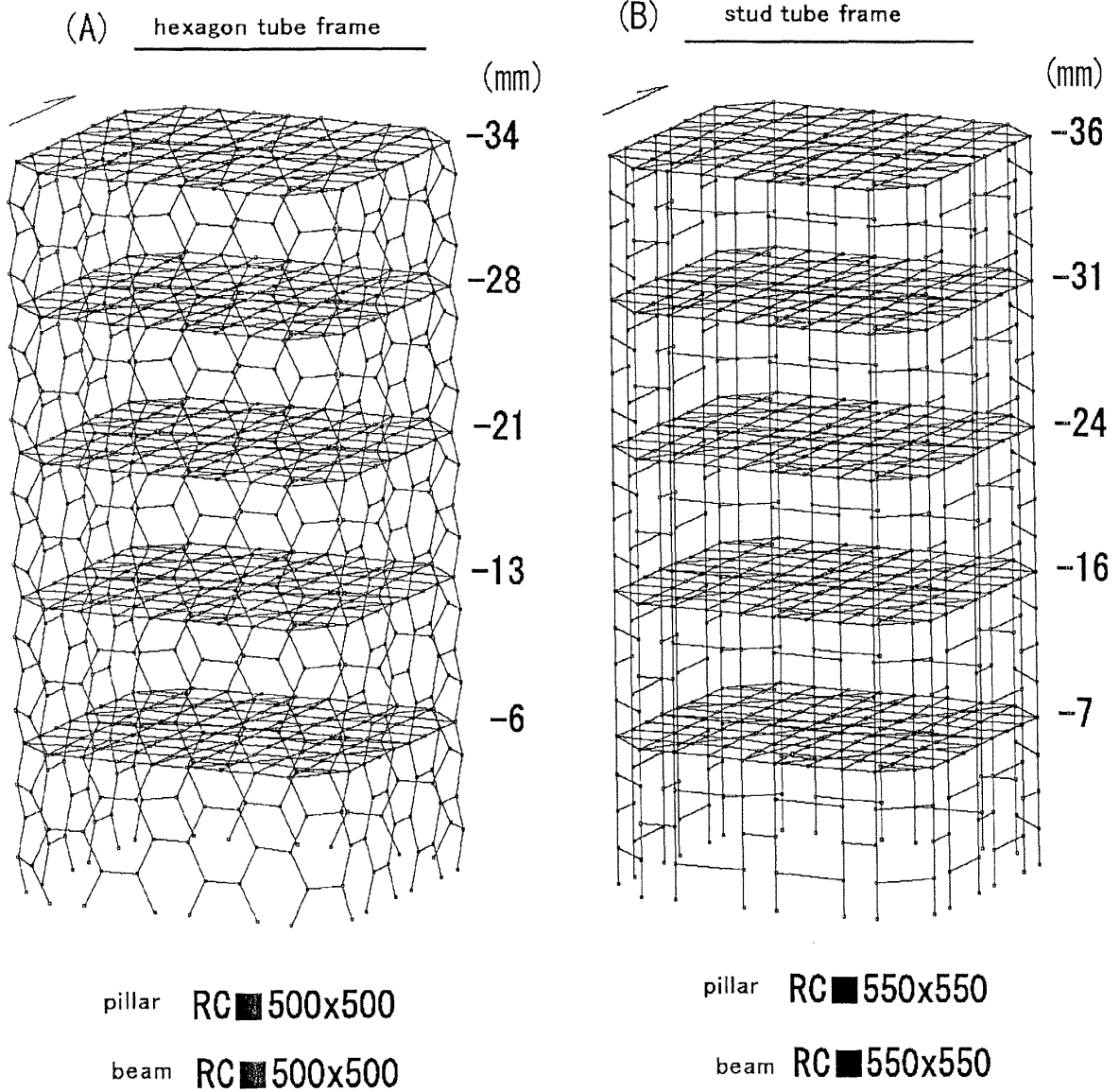


Fig.2D < comparison of stress generated on member in the same horizontality force >

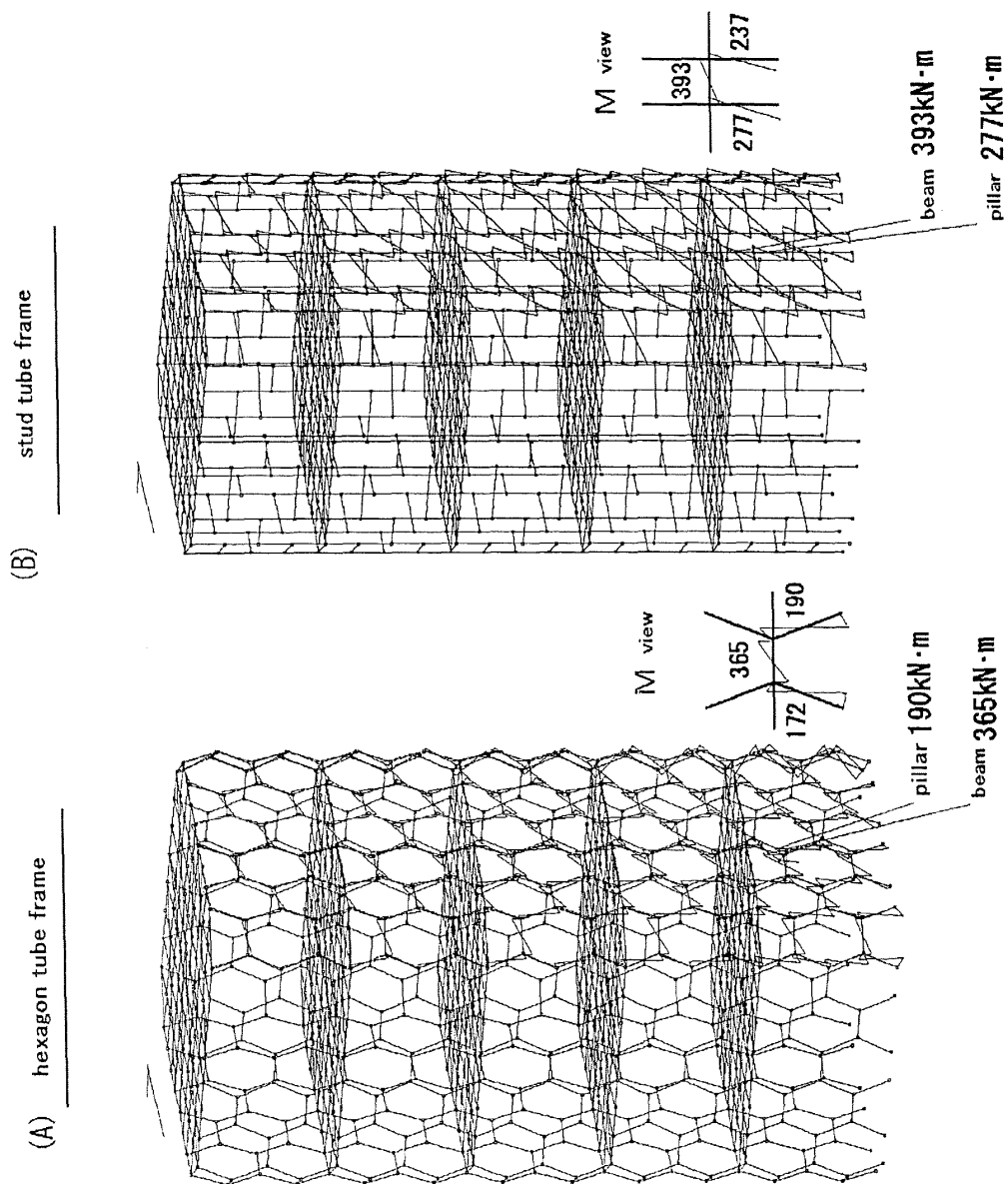


Fig.3

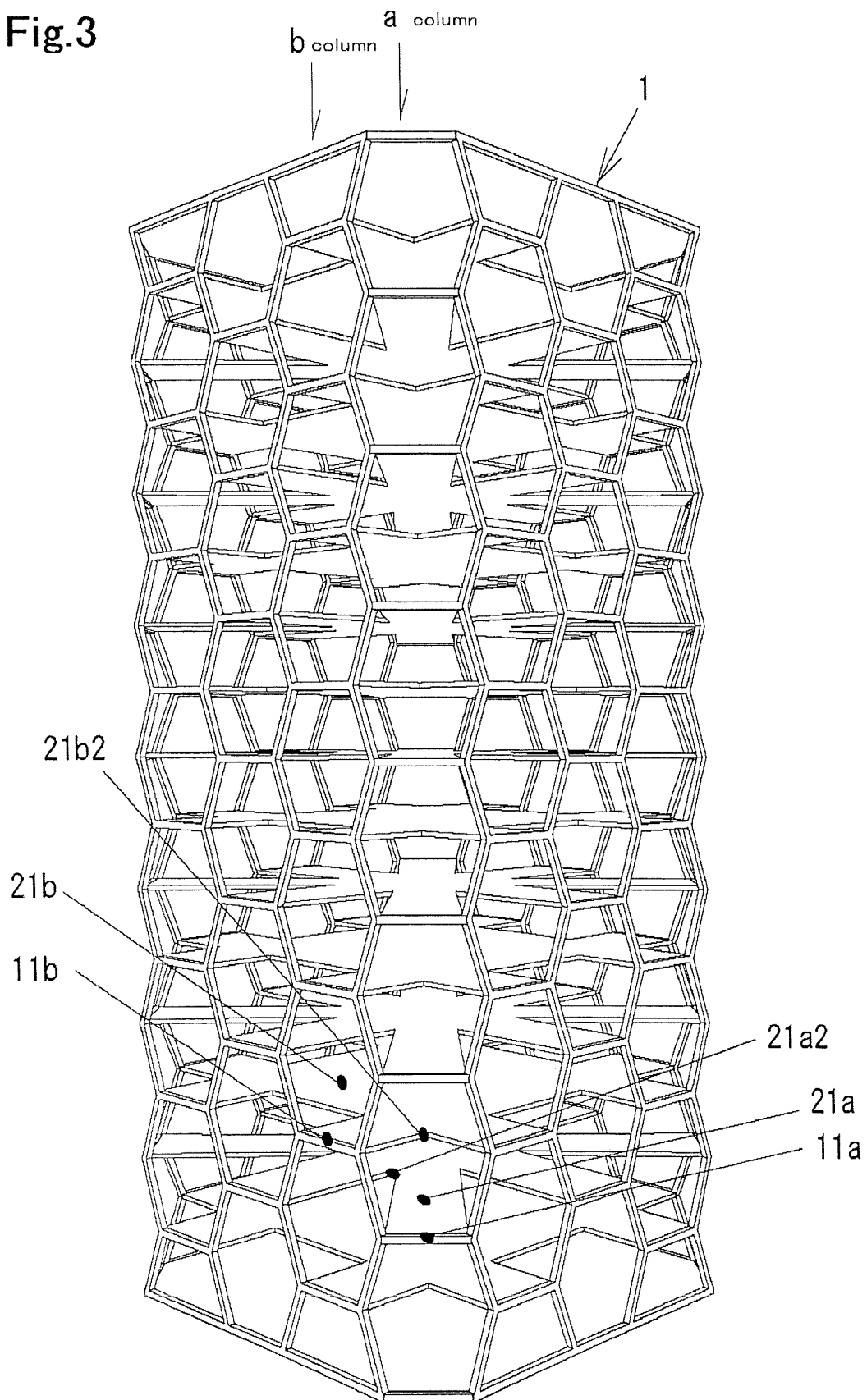


Fig.4

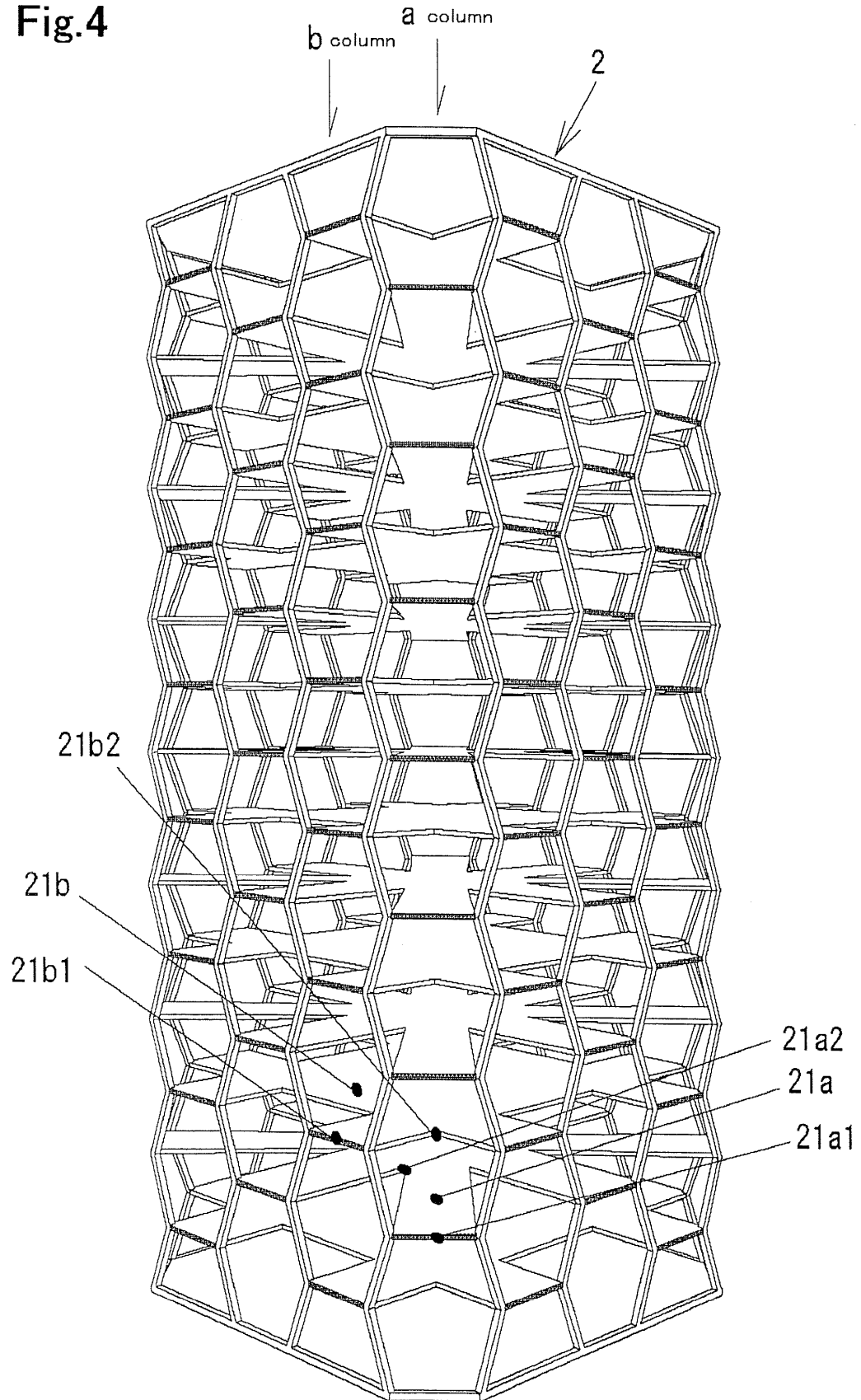


Fig.5

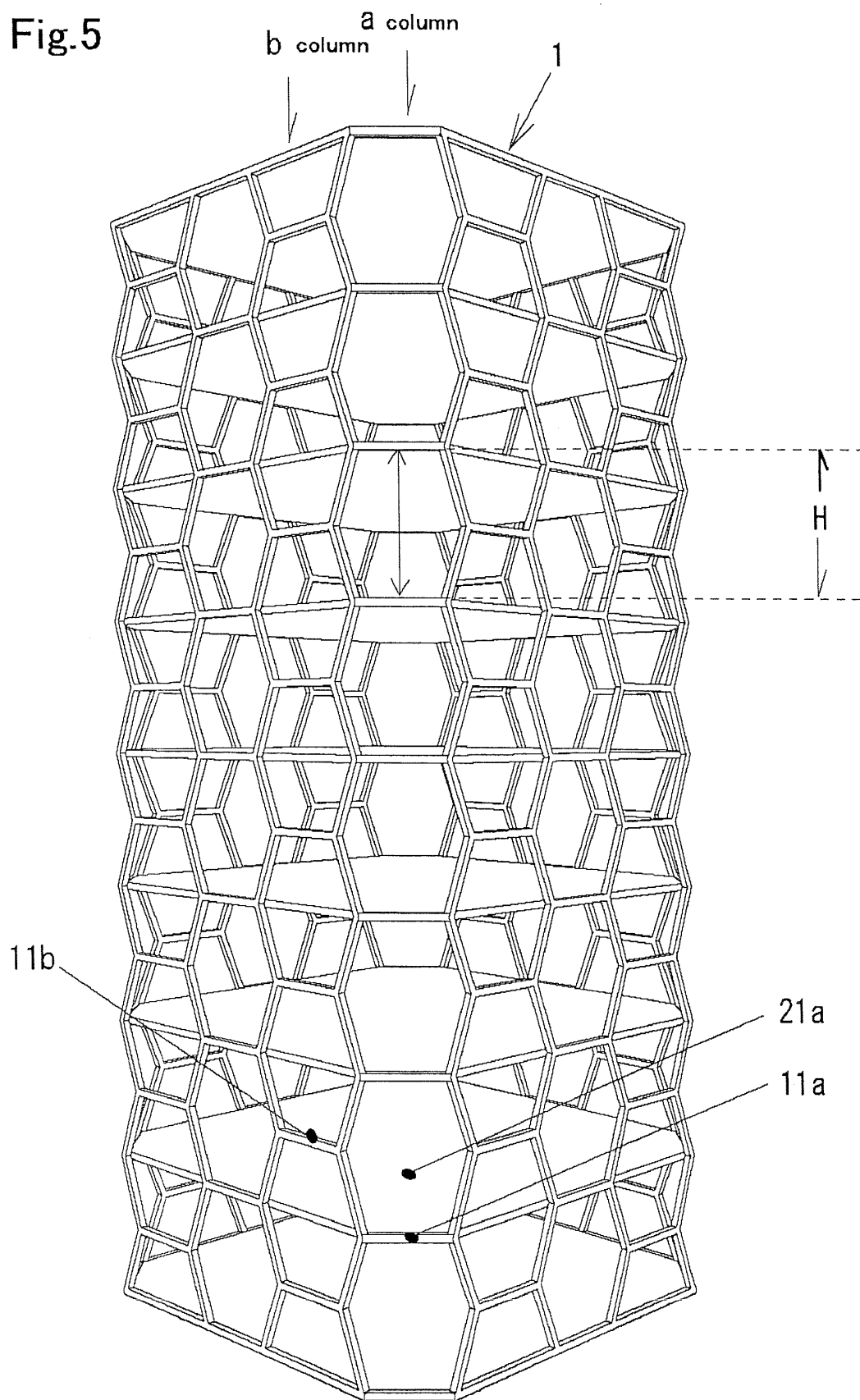


Fig.6

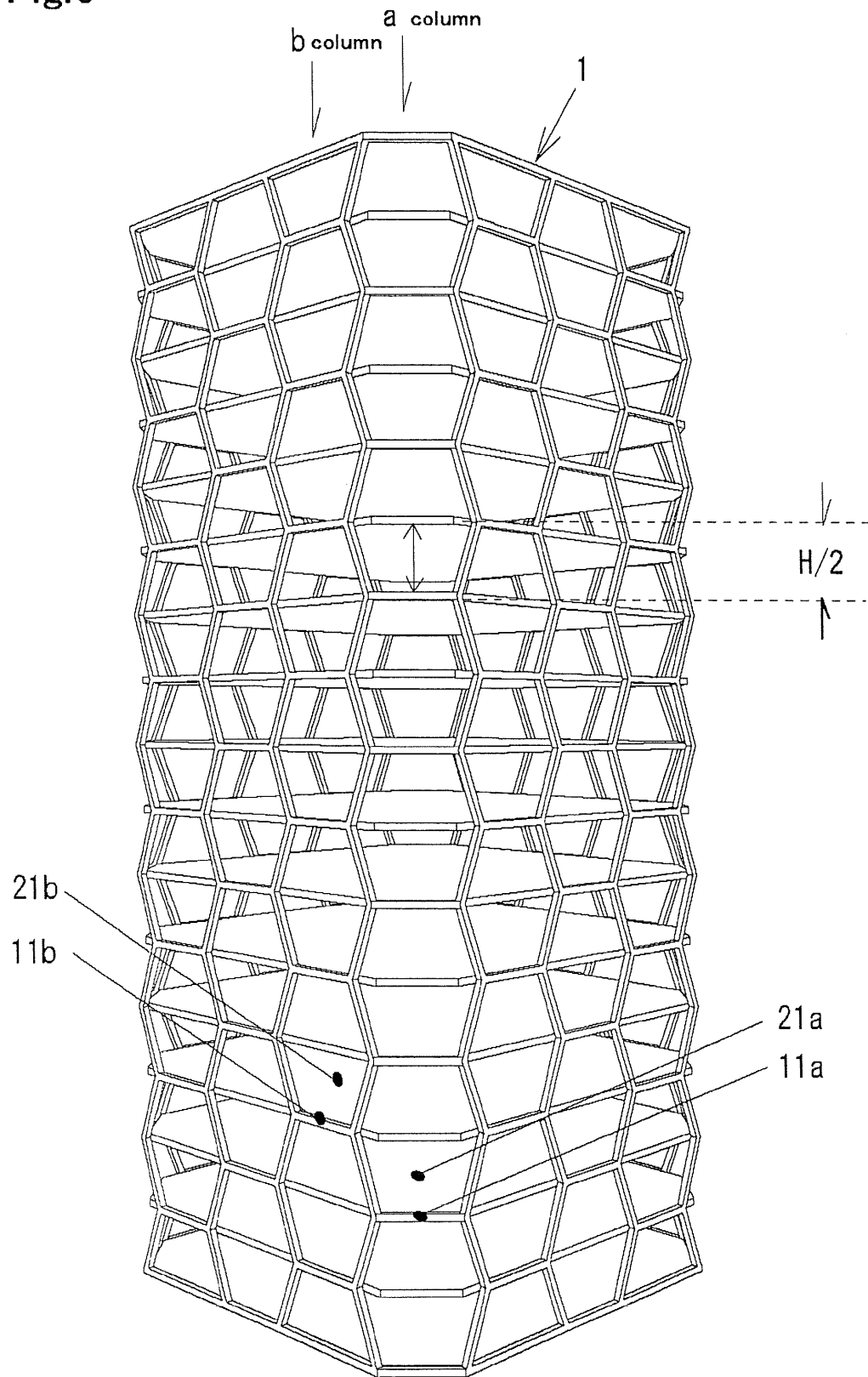


Fig.7

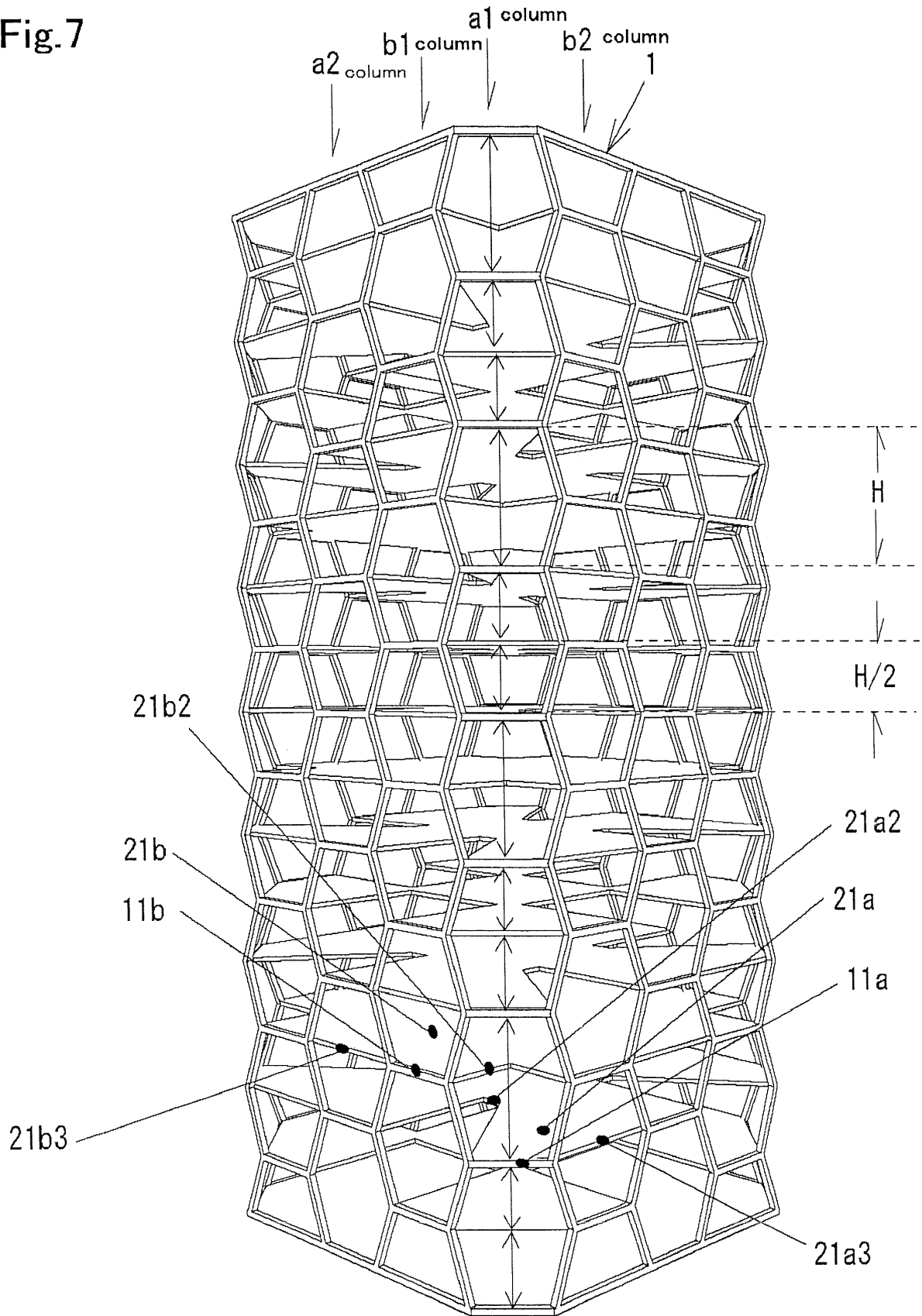


Fig.8

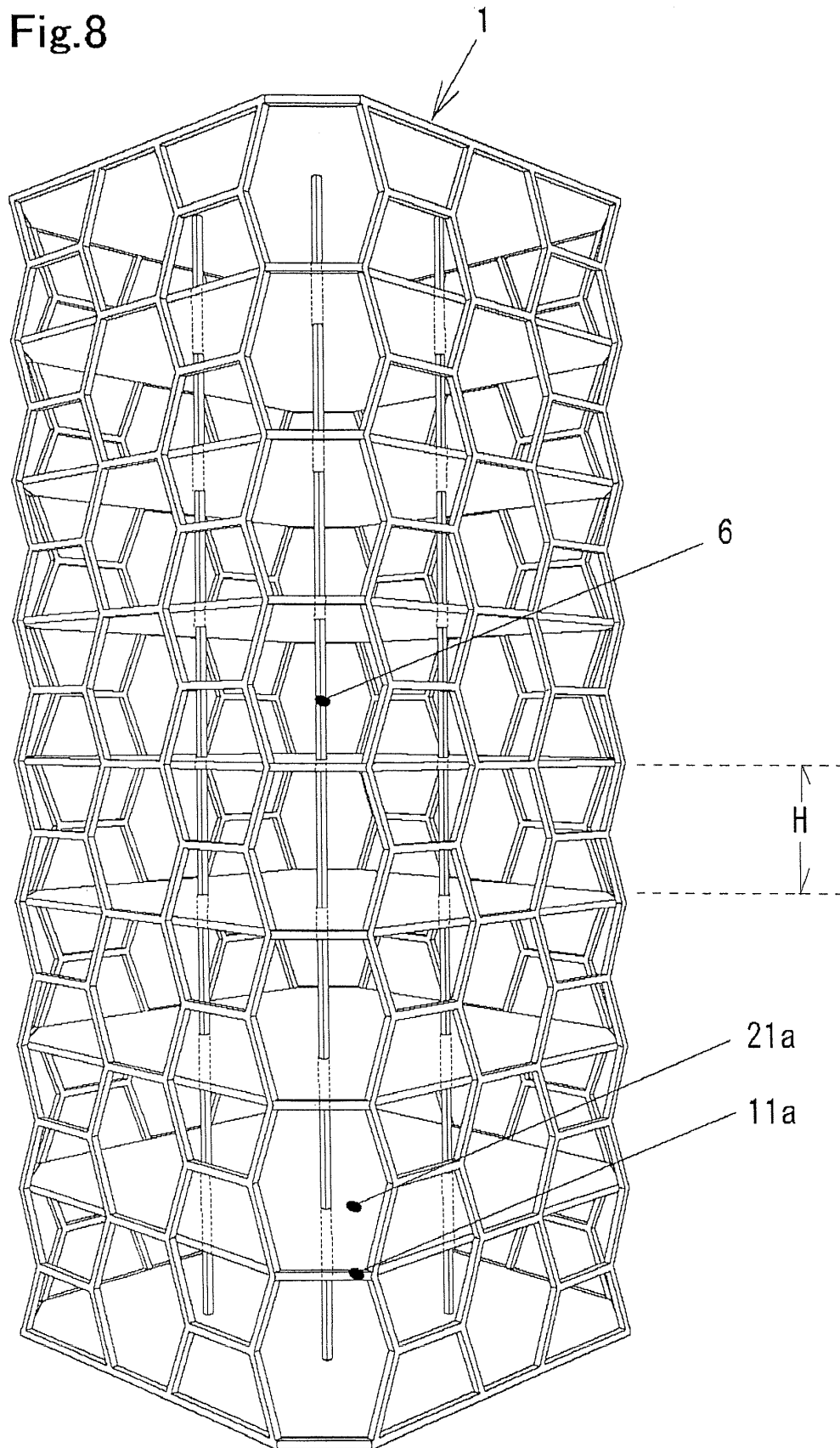


Fig.9

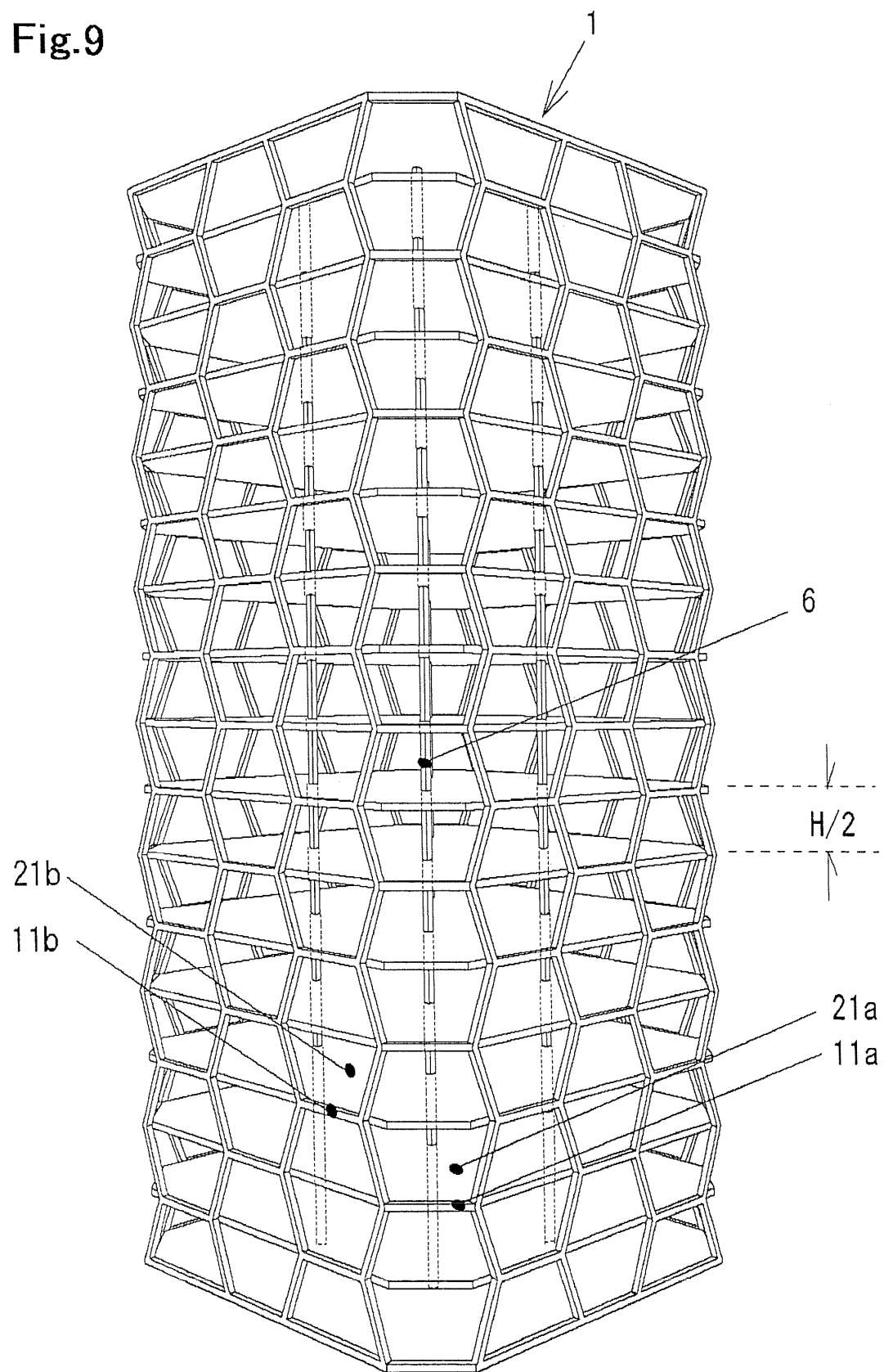


Fig. 10

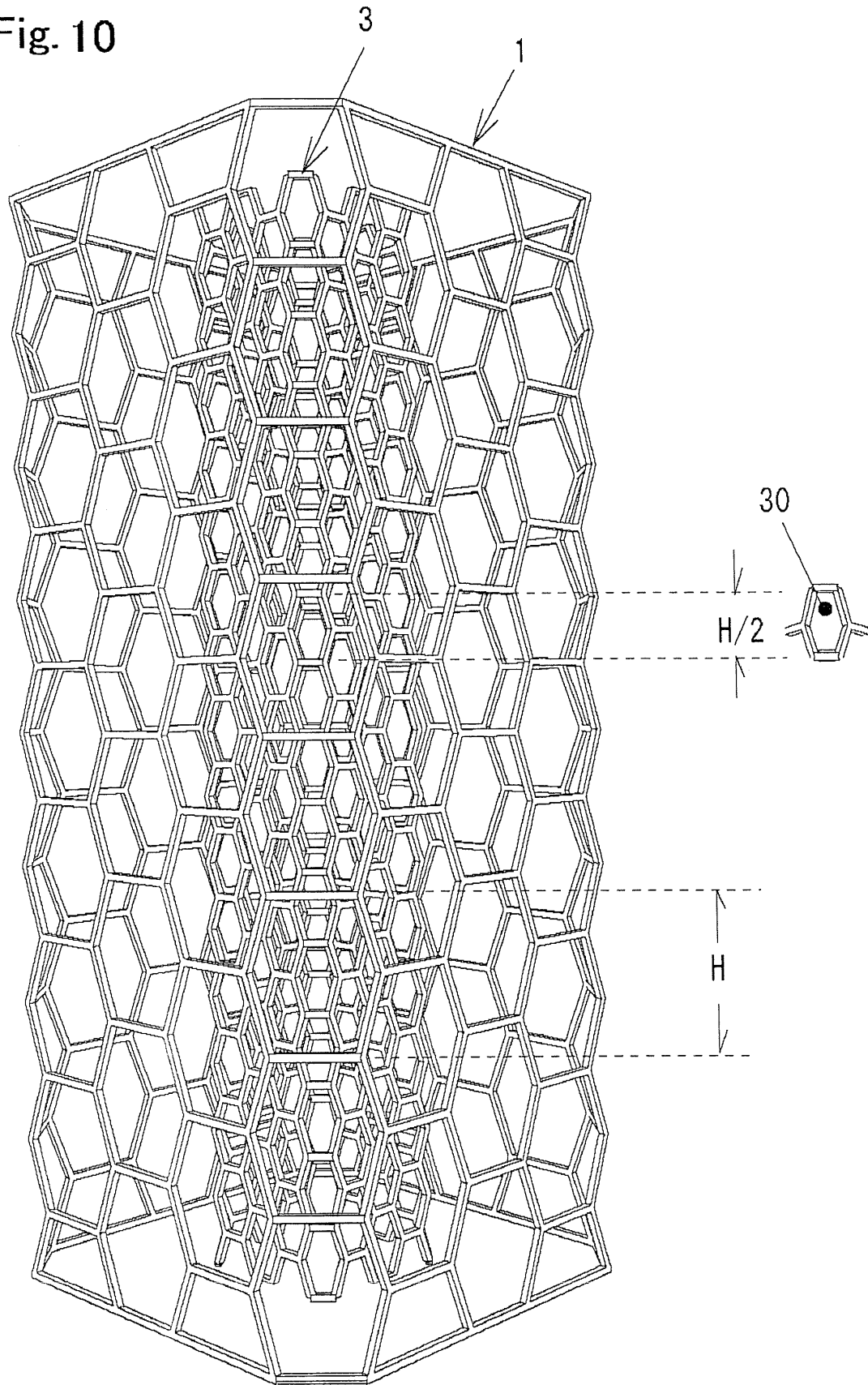


Fig.11

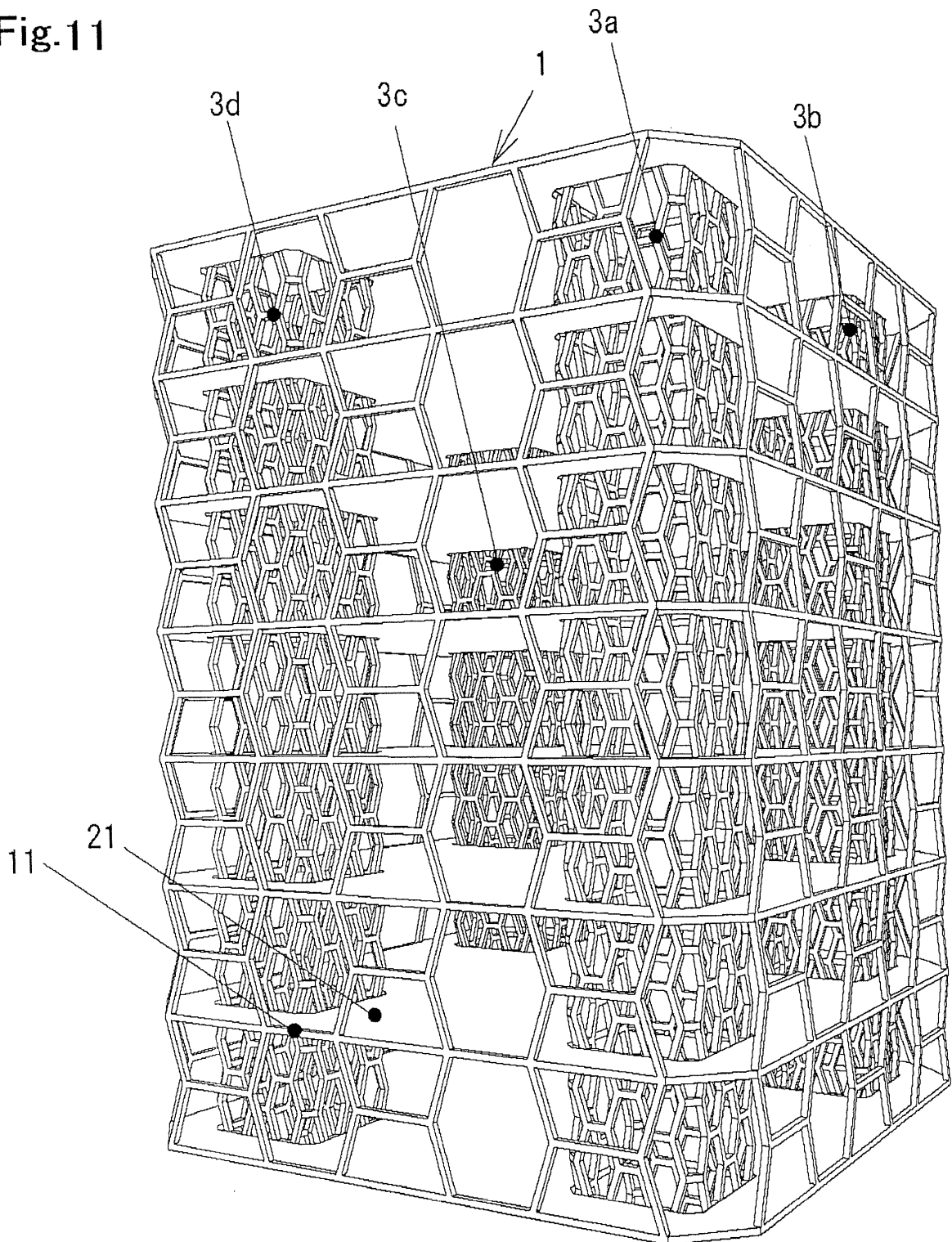


Fig.12

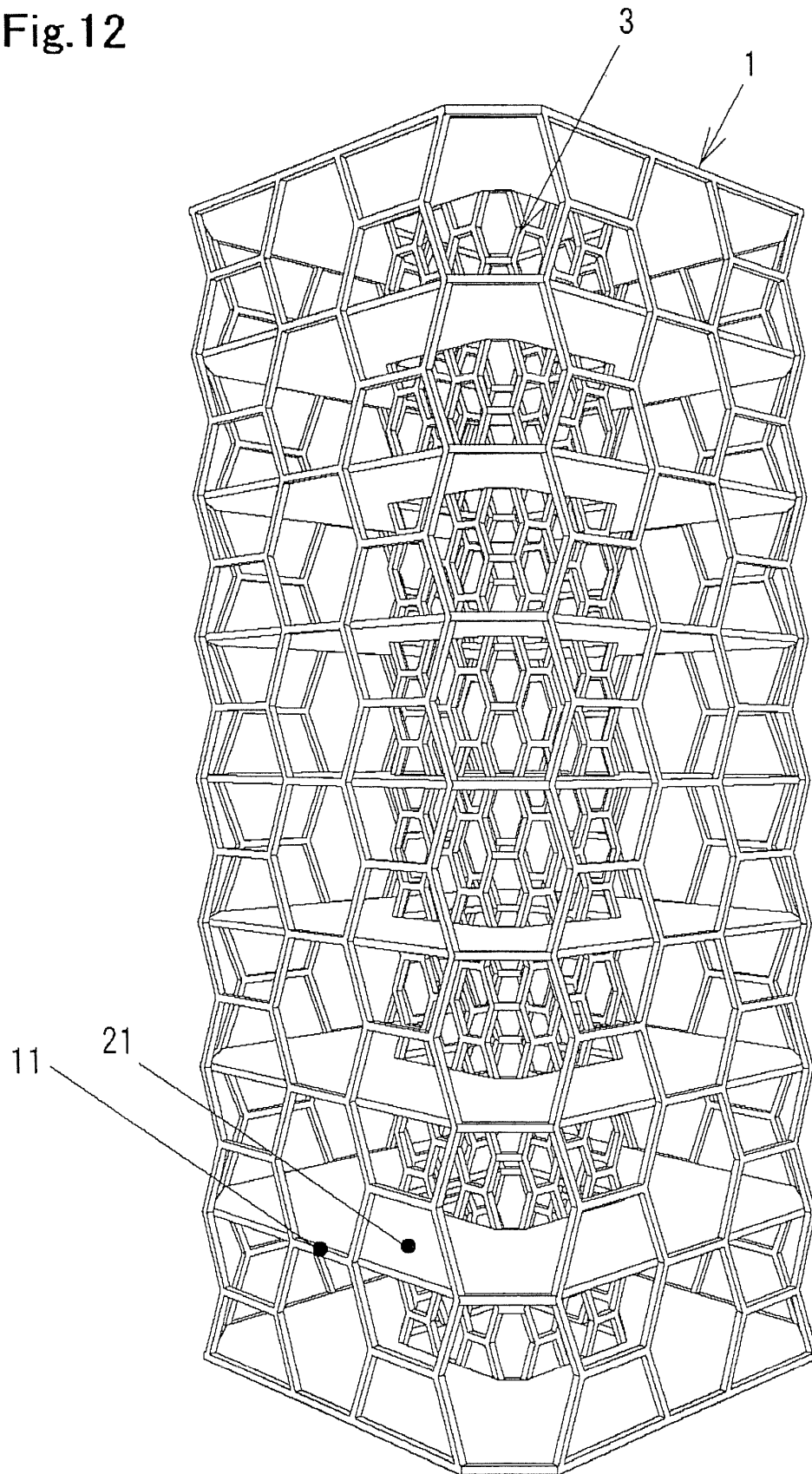


Fig.13

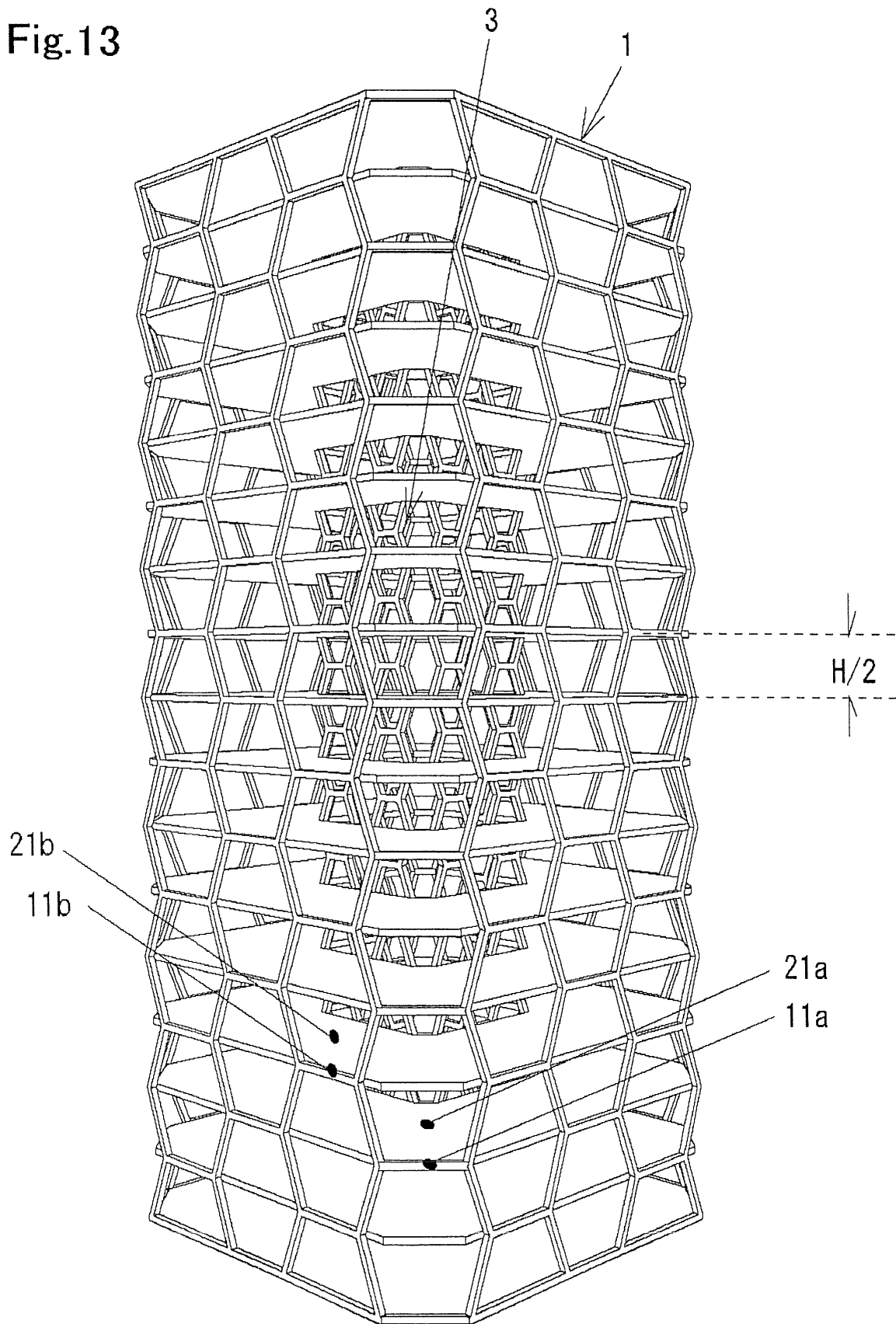


Fig. 14

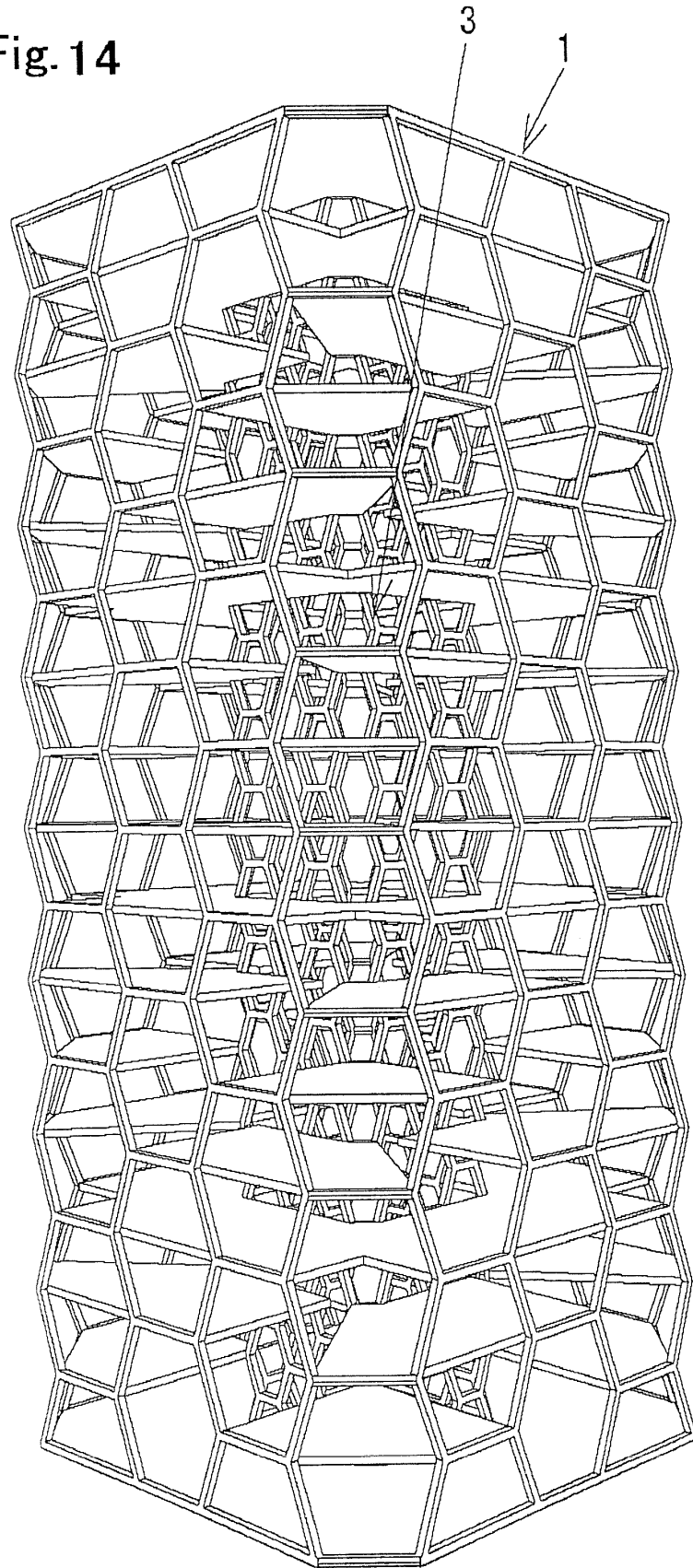


Fig. 15

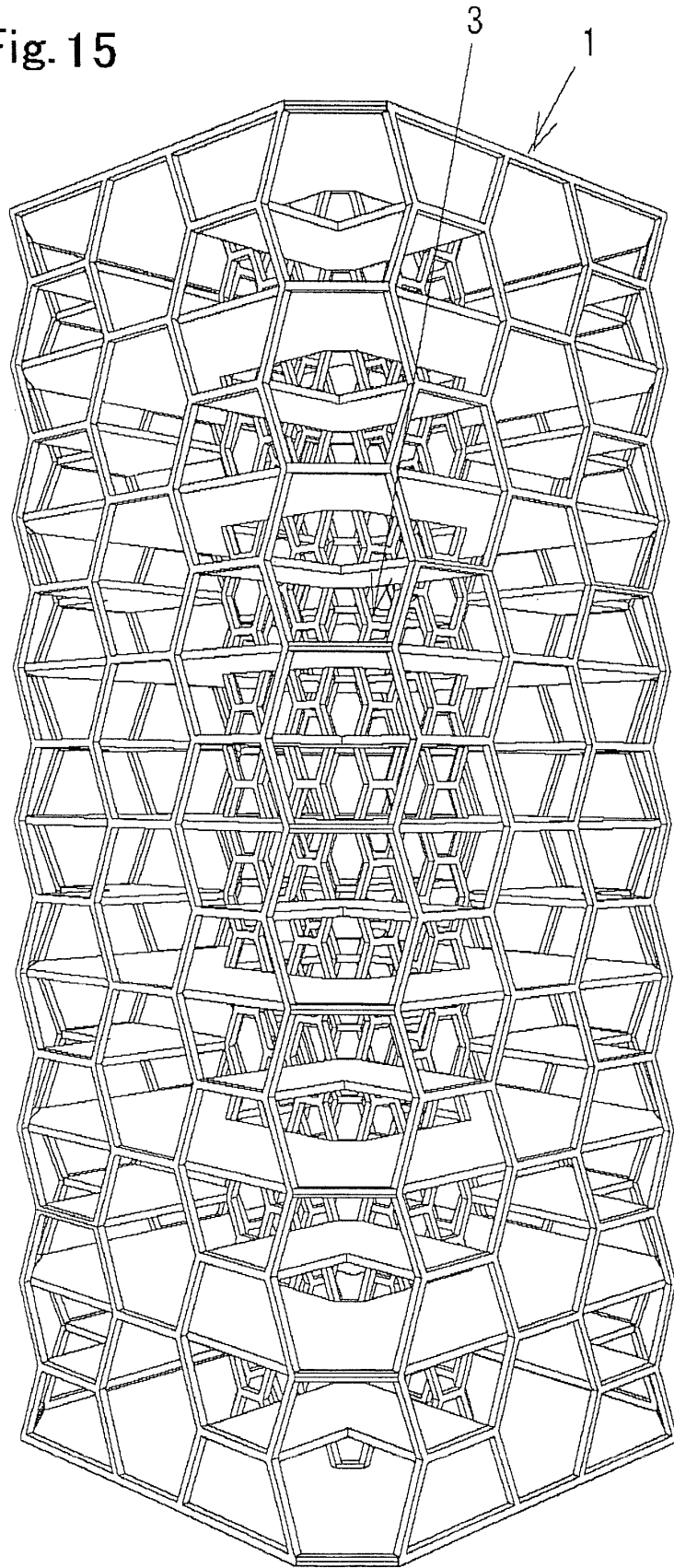


Fig. 16

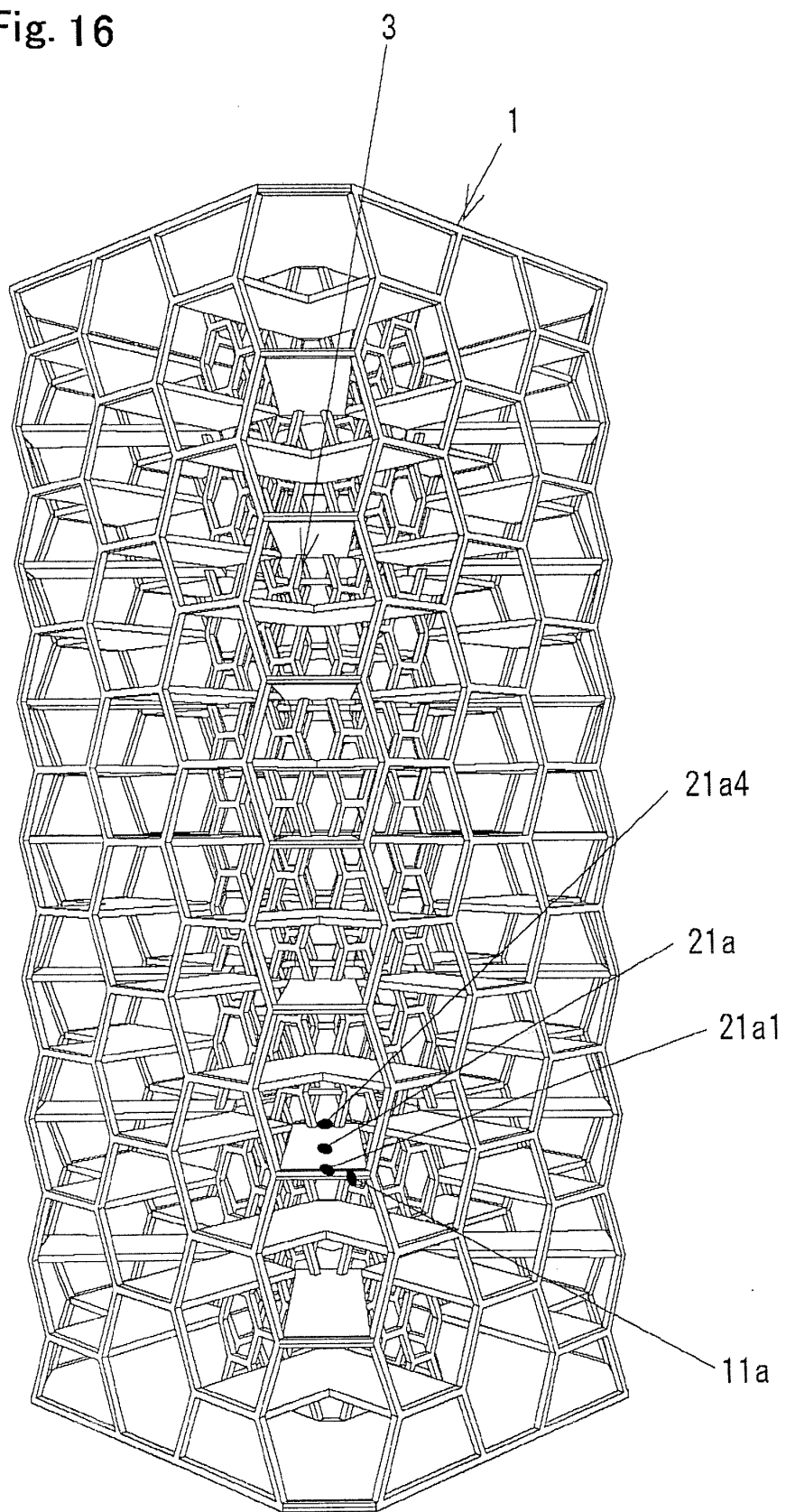


Fig. 17

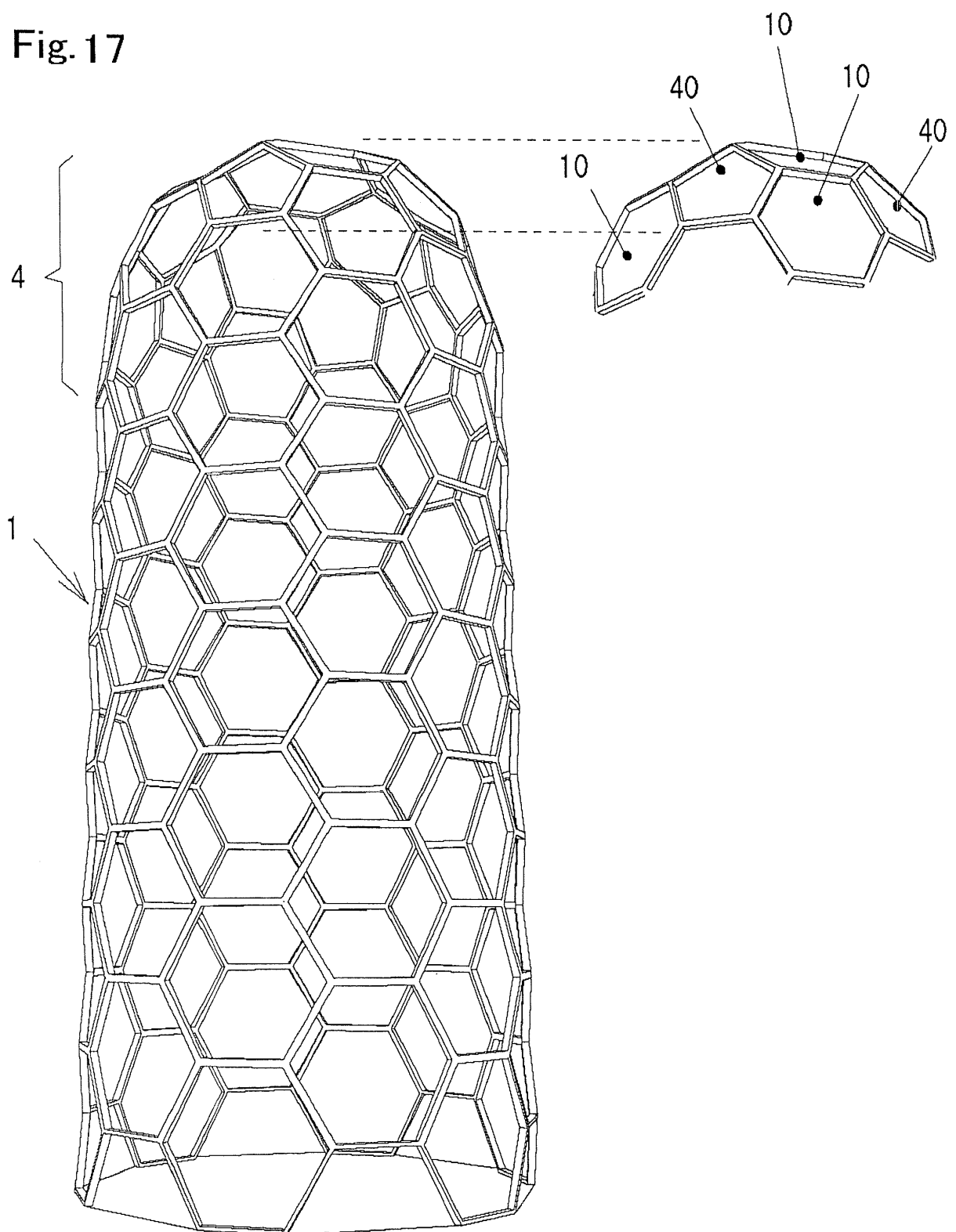


Fig. 18

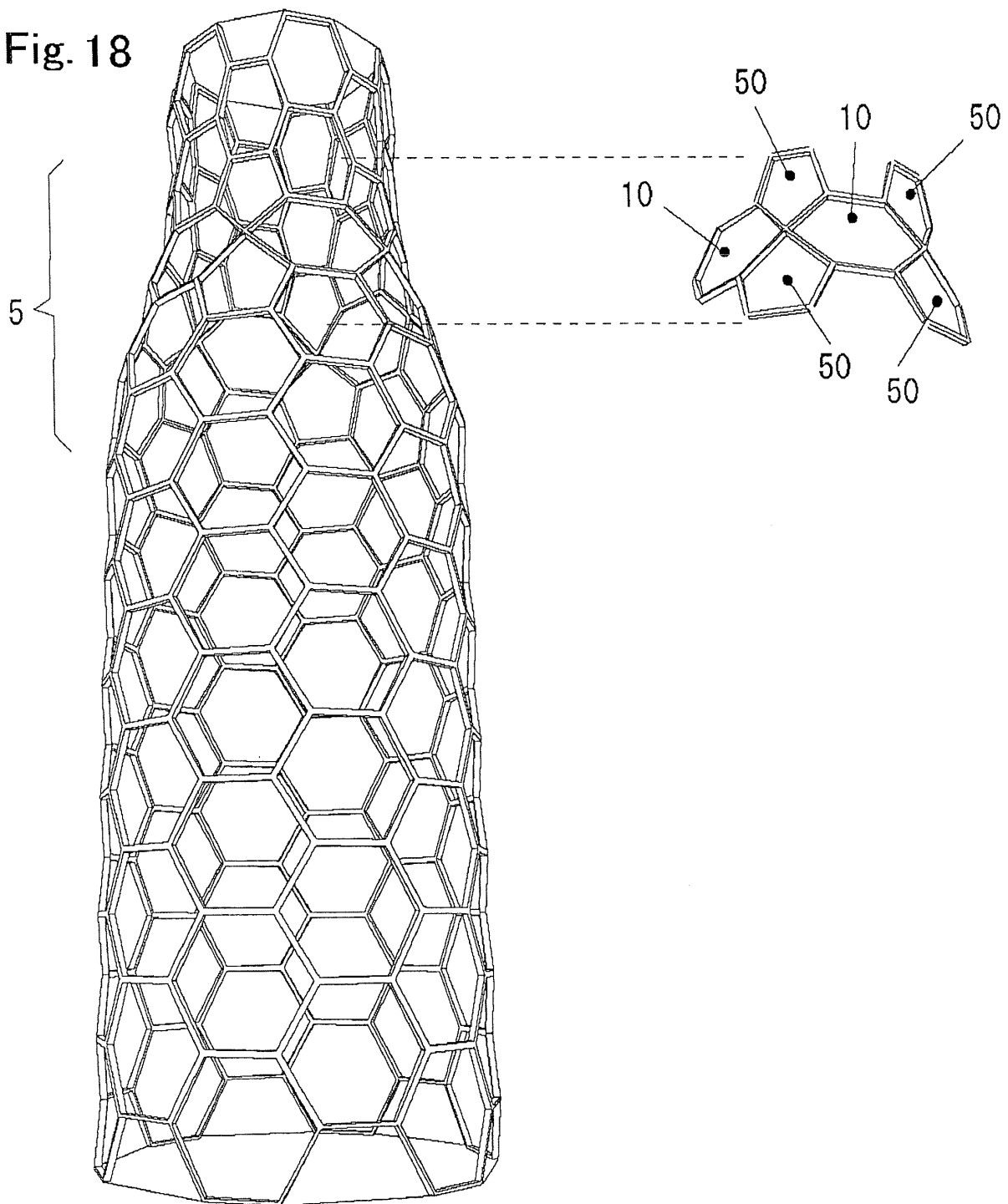


Fig. 19

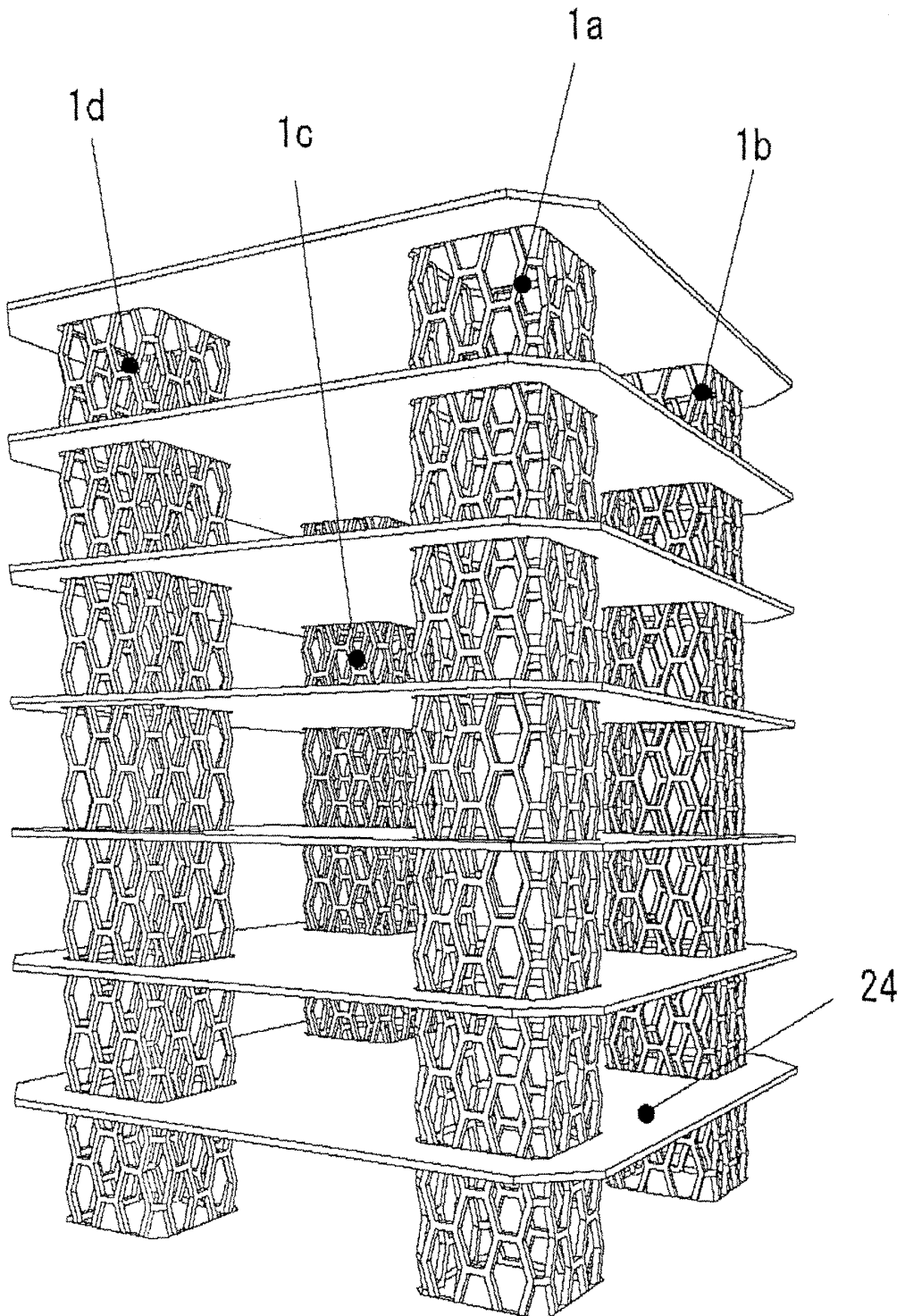
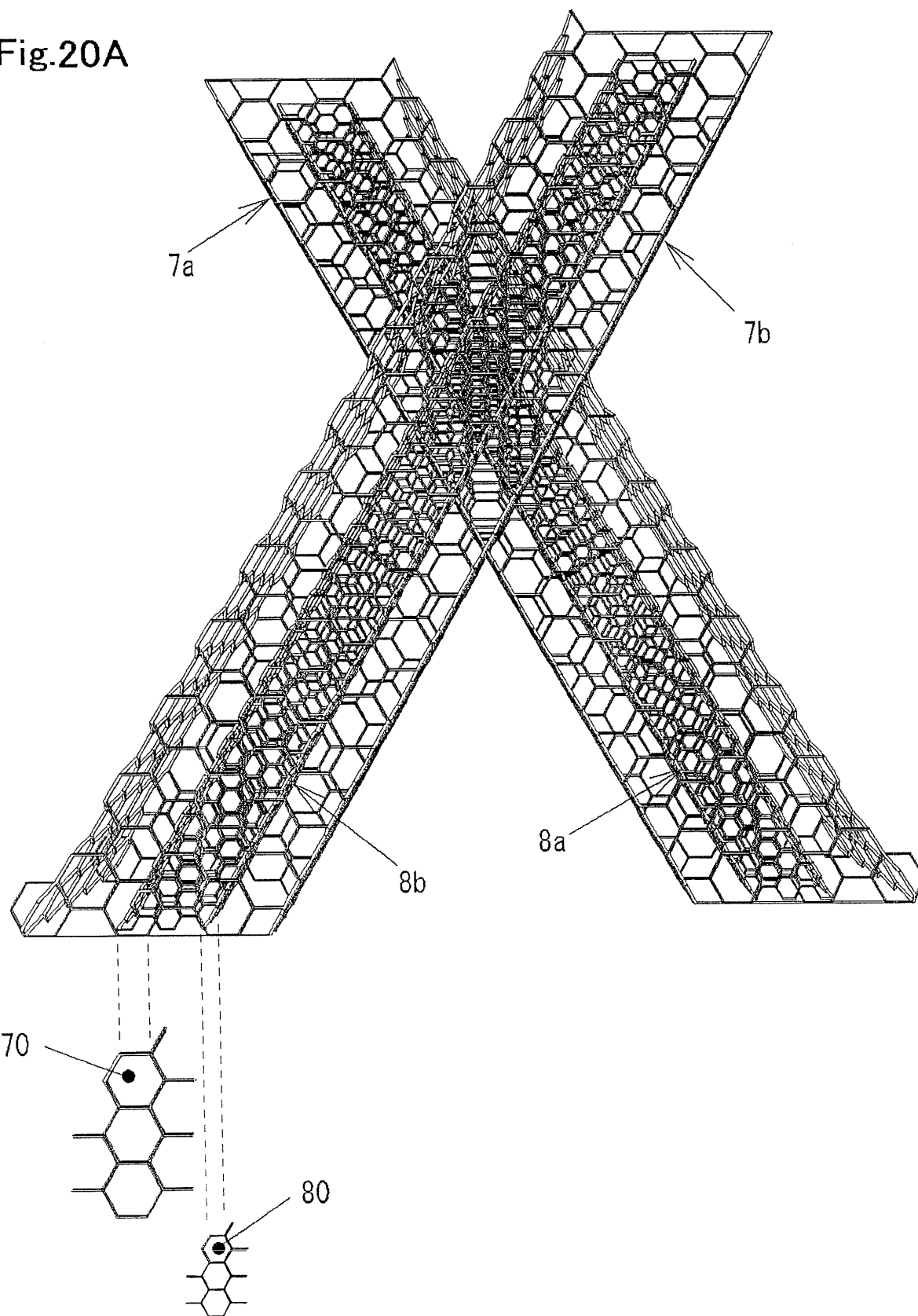


Fig.20A



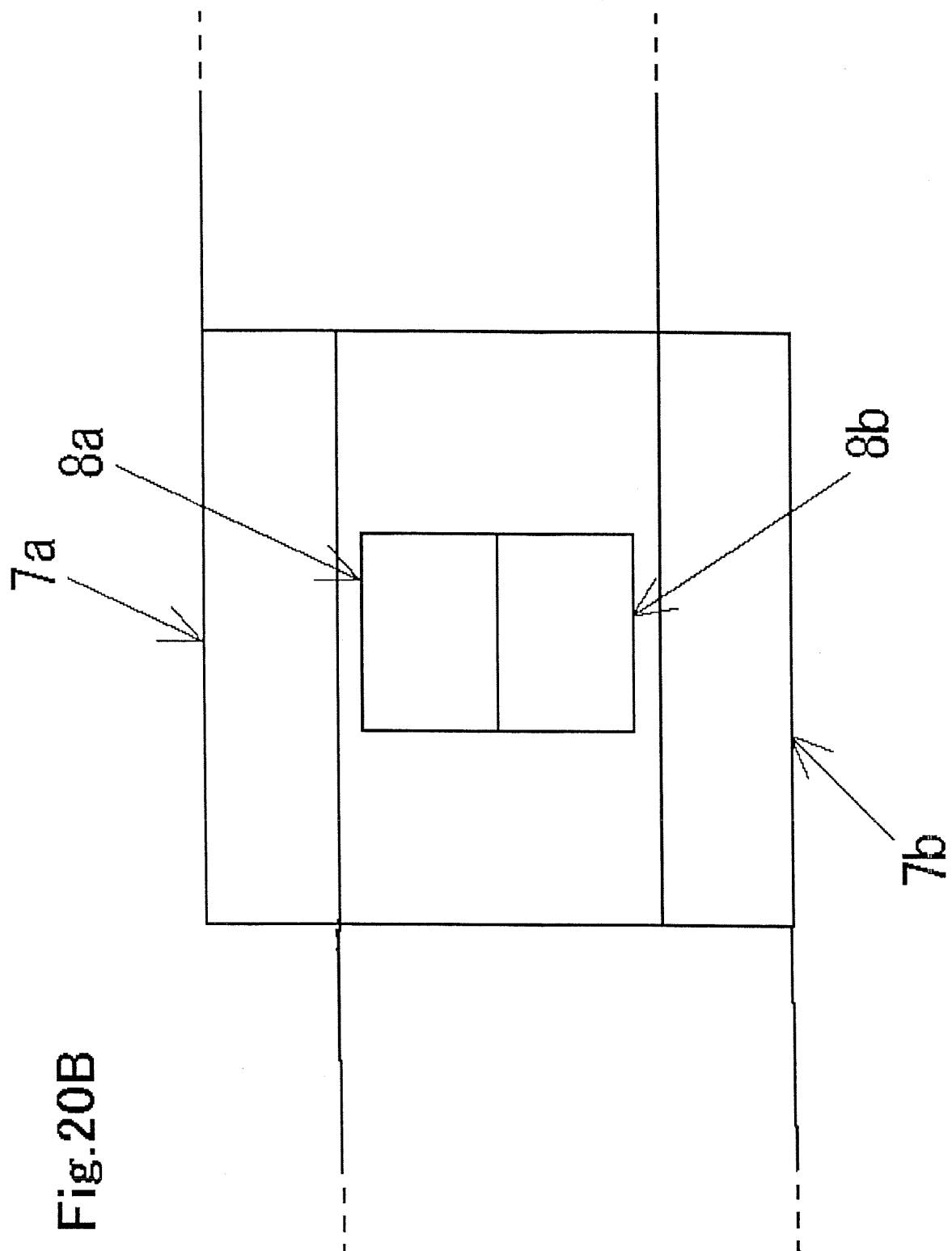
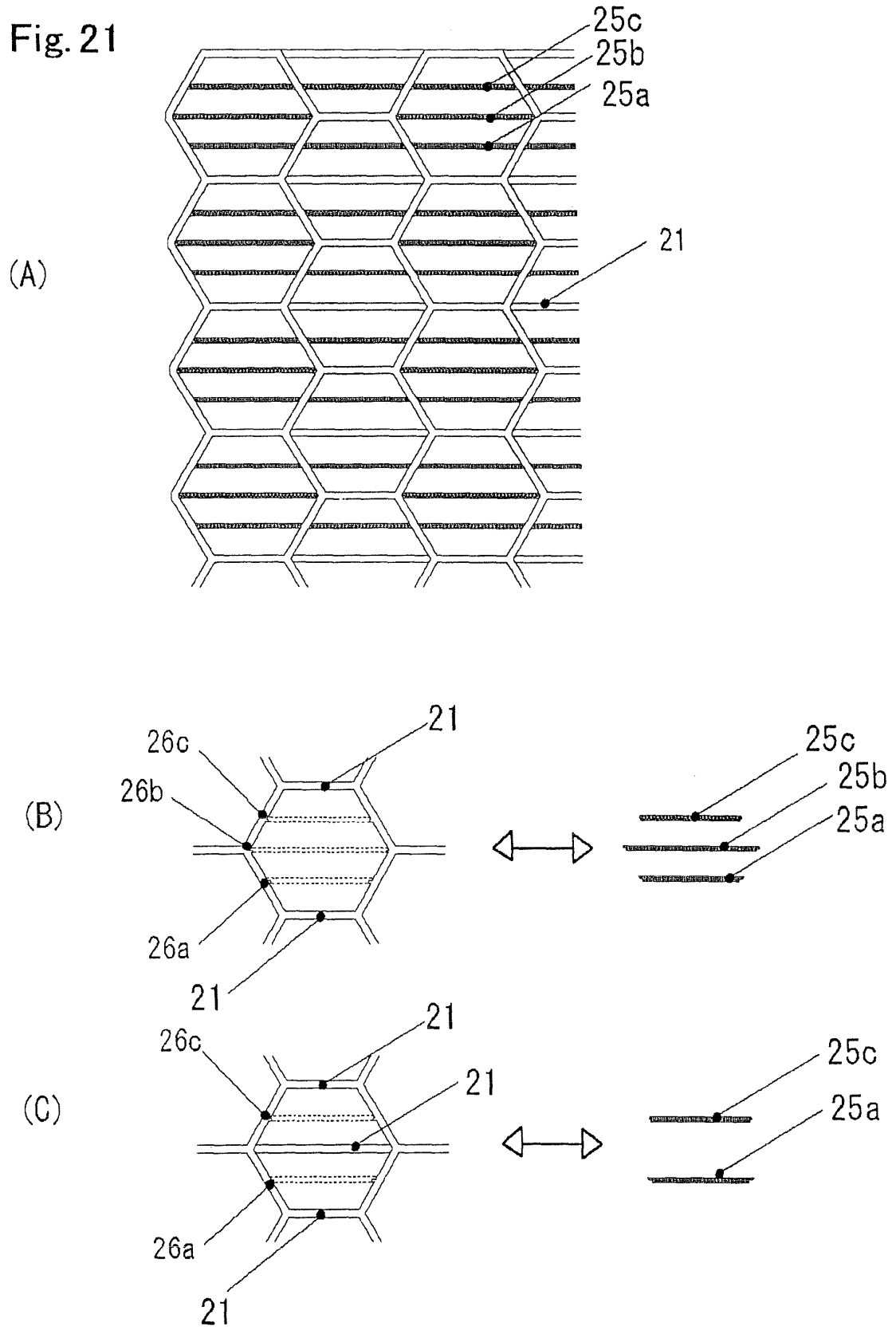


Fig. 21



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/305971

A. CLASSIFICATION OF SUBJECT MATTER E04B1/18 (2006.01), E04B1/34 (2006.01)		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) E04B1/18 (2006.01), E04B1/34 (2006.01), E04B1/00 (2006.01), E04B1/19 (2006.01), E04H9/02 (2006.01)		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2006 Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 7-197535 A (Shimizu Corp.), 01 August, 1995 (01.08.95), Par. Nos. [0013] to [0020]; Figs. 3, 5 (Family: none)	1-19
A	JP 10-311160 A (Shimizu Corp.), 24 November, 1998 (24.11.98), Par. Nos. [0014] to [0020]; Figs. 1 to 3 (Family: none)	1-19
A	JP 1-322041 A (Misawa Homes Co., Ltd.), 27 December, 1989 (27.12.89), Page 3, upper left column, line 18 to upper right column, line 15; Figs. 1, 4, 11 (Family: none)	1-19
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 18 April, 2006 (18.04.06)		Date of mailing of the international search report 25 April, 2006 (25.04.06)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/305971

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2004-251056 A (Shimizu Corp.), 09 September, 2004 (09.09.04), Par. Nos. [0005], [0006]; Fig. 1 (Family: none)	13

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2002317565 A [0007]
- JP 2004251056 A [0007]
- JP H07197535 B [0007]
- JP H094130 B [0007]
- JP H1018431 B [0007]
- JP H0960301 B [0007]